THE PRICES OF THE LABOUR IN Ship-Building Adjuſted:

OR, THE MYSTERY OF Ship-Building Unveiled.

BEING,

A Brief Explanation of the Value of the Labouring Part in Ship-building; from a Ship of the biggeſt Magnitude, to a ſmall Boat.

FIRST,

Shewing the Working the whole Ship, according to the Length, Breadth, Depth and Girt; and then by Sub-diviſions ſhews the Value of every particular Part.

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TO THE
Able and Experienced
SHIPWRIGHTS.

Bother Chips,

EVER ſince I had the leaſt Knowledge of our Buſineſs I have had a real Value for all Able Workmen, meaning thoſe that have ſerved ſeven Years to the Buſineſs, without any manner of Fraud.

There is really no Occaſion to tell you of the Difference which is often obſerved in thoſe that barely have the Name of Shipwrights, without being any ways qualify'd to perform a Day's Labour, or any other Part that belongs to the Trade.

I could have wiſhed to have had more Leiſure to compleat ſuch an unrepeated Obſervation, believing it will not be only of Service to Able Workmen, but alſo of vaſt Service to the Publick, and for ſuch Reaſons as follows.

Firſt, I have obſerved when one of ſuch a Function has had Encouragement he cou'd do twice as much as at another Time, and when diſcouraged altogether as bad.

And, in my Opinion, nothing can better encourage Men than when they have to the Value of what they Earn; which I am poſitive moſt Able Men would have twice the Allowance that they have now, and Hundreds of others has really twice as much per Diem *as ever they could deſerve.*

Beſides, was Able Men encouraged, they would exert both their Skill and their Labour, which would be a Means to improve the Buſineſs, and make the worſt Sort endeavour to imitate their Example.

All that I have elſe to ſay is, That I deſire my Endeavours may be accepted, according to my Deſign, which is a General Good.

I Remain,

Your humble Servant,

WILLIAM SUTHERLAND.

THE
PRICES
OF THE
Labour in Ship-Building Adjuſted, &c.

By Hammer and Hand all Arts do ſtand.

IT's reported that the Ancients were very ſolicitous about any Diſcoveries tending to the Common Good, ſo far that they at ſeveral Times, and on divers Occaſions, returned their grateful Acknowledgment to the Muſes for beſtowing ſuch Favours upon them, as making them the Inſtruments of bringing to Light ſuch Matters, which had laid concealed from preceeding Generations.

It's recorded that *Pythagoras* ſacrific'd a hundred Oxen at the time he diſcover'd the Square of the Perpendicular and Baſe to be equal to the Square of the Hypotenuſe: And the famous *Archimedes*, how violently he was tranſported at the time he invented a Way to meaſure *Hiero*'s Crown, that it's ſaid he ran about naked.

But to forbear naming a great many others that have been very induſtrious about improving themſelves in divers Arts and Sciences, and look back and obſerve how few there is now that either do themſelves, or are willing any others ſhould be young or new Projectors, as they term them.

It is really very admirable to ſee what Abundance of Handicrafts there be in the World, that lives one by the Aid and Aſſiſtance of the other, and what Care and Pains has been taken to try what Quantity of Buſineſs lyes in Man's Capacity daily to perform.

As in ſeveral Trades that are extended into divers Branches, how every Branch is willing to get Succour from the Root, or Gain that's made by the ſaid Occupation. Notwithſtanding if there be any Branch that has the Preference, or in any manner upholds the other, why then he will be ſure to have a Gain out of every one that he ſets to work or employs.

Either he will enquire ſo far into the Secret of his Journeyman's Ability that he will be ſure to make him work for the ſmalleſt of Gains, or otherwiſe he will be ſure to have a great many Servants, according to his Conveniency and Privilege he has in the ſame Occupation.

And whether this can be meant the pulling down one and ſetting up another, I ſhall not enquire.

Neither can I believe that ſuch a Practice can be altogether unreaſonable, becauſe of the Depravity that governs in the greater Part of Mankind, that was they not ſtinted or tasked, in all likelyhood they would do nothing, neither for themſelves or poor Families, nor matter if they Starved, or come to the Pariſh. For a great many Men are of that Temper, that they could Dye rather than be conſtantly confin'd to Buſineſs, ſo that a little at one time, and a little at another would be beſt for them.

But what is, or ought to be moſt narrowly conſidered than the Humour of the Mechanick, or Workman, in divers Arts and Miſteries, is the Utenſil compoſed, or made by the ſaid Handicraft Man.

Which, for Brevity ſake, I ſhall direct my ſelf, towards a Ship or ſuch Machine, which is the very Matter deſigned to be ſpoke of.

A perfect Ship fit, and every ways qualifyed for Uſe, doth employ Abundance of Mechanicks, divided and ſubdivided into a Number of Branches.

For what originally, nay and in divers Places, is ſtill performed by one Man, or one Sort of Men in Ship-Building, is now performed by ſeveral.

As Firſt, The principal Ship Carpenter, or he that Mechanically puts the grand Machine together; for at preſent I ſhall not mind the Artiſt that makes the Draught or Pattern, nor he that from ſuch a Pattern tranſcribes the Model to Foot Meaſure, called Croſſing or Marking the Molds, neither he that Converts and Moulds the Timbers.

But the bare Handy-Work, or Ship-Building, is now performed by Shipwrights, Caulkers, (as they term Wiſe-men of *Gabel*) then Sawyers, Smiths, Joyners, Carvers, Painters, Glaziers, Block-makers, Boat-Builders, Oar-makers, Sail-makers and Weavers, Dreſſers and Spinners, then Ropemakers, and thoſe that provides for their Buſineſs.

Then Plummers, Platerers, Coopers, and if I was to enumerate every Trade that has any Dependance on this Noble Machine, it would be really almoſt every Trade throughout this Kingdom. But what I have named are only ſuch as are employed in Building and Equipping the ſaid Machine, without mentioning the Defence, as Guns, and what belongs to that Part.

Our Practice is almoſt as Ancient as Time it ſelf, as in the Caſe of *Noah*, and ſo deſcending down to this Generation, with mighty Improvement, as may be obſerved that our Buſineſs, in ſome meaſure, is almoſt perfect.

Our Prices are generally known for either Stuff or Workmanſhip, ſo far, that there is Abundance of both Men and Maſters, which knows very nicely the Value of Building any Ship according to her Magnitude, as well as any particular Part of her; but then this is only known to ſome particular Perſons, by which Means the Ignorant, or thoſe that know little of ſuch Task-work are almoſt ruin'd by engaging in the ſame.

And not only ſo, but it is really a general Detriment, both to the Conſumption of our Nation's Timber, and alſo at ſeveral times the Deſtruction of a whole Ship's Crew.

For when a poor Man has engaged himſelf in a Piece of Work, and obliged by Contract to comply, or elſe his Money, as Wages, lyes at Stake for doing the ſame; and perhaps not any ways able to bear a Loſs, and to work for half Wages, whilſt his poor Family is ſtarving at Home.

Why in ſuch a Caſe this Jobber will, and indeed not much againſt Reaſon, pay his Work off upon the blind Side, as it's termed, which is to ſlight and cobble his Work, as much as he poſſibly can, to conceal it from the Eye of his ſaid Maſter or Overſeer; which great Fault cannot be committed in any worſe than the principal Ship-Carpenters or Calkers, and this is in ſlighting his Work in the Hull of the Ship under Water; but for the Caulker he knows as well what he can do, or may be done in his Buſineſs, as any Man can tell how many Inches or half Inches is upon a two-foot Rule, and therefore he will not be put upon, or work for ſmall Wages; ſo that the Matter which requires to be conſidered is purely the Shipwright Buſineſs, to let them know what may be done with Safety, and a reaſonable Gain.

I ſhall endeavour to ſhew what the whole Ship is worth Building, as to the working Part, and after I have conſidered the Difference in the whole Ship, according to the Length, Breadth, Depth or Heights; I ſhall divide and ſubdivide the Parts, and ſhew what each Part is worth; either as firſt putting of it together, or in Firſt building the Ship, and alſo in rebuilding of her, or pulling out one Part and putting another in the Room of it.

Experience has pretty well inform'd us, what may be hurry'd over by any Man, in any Branch of ſuch Handicrafts, and what is given *per* Tun for building any Sort of Ship, but however thoſe Rules are not made General, neither, if nicely look'd into, will be found reaſonable; for firſt it is very common in making Bargains of this Nature; that the Price is given from the Tonnage of the Ship which muſt of conſequence be very Erroneous; ſince there is no exact Rule to find it, ſince two Ships may be of equal Length, Breadth, and Depth, and yet one ſhall carry, 2 or 3 hundred Tuns more than the other, beſides the Shape of the Body will require a different Price in the Workmanſhip, as well as in the Material.

As a blunt Ship will require more Pains and Time to build than a ſharp Ship from the Bending the Planks, (by burning) that are brought about the Bow and Buttock of ſuch a full Ship.

And again, the extraordinary Accommodation and Finiſhing in one Ship more than another, will add to the Time and Labour requiſite to build them.

I ſhall endeavour from ſuch Conſiderations to ſhape a general Rule, for the Value of Building any Ship or ſuch a Machine.

Then in the Room of taking the Length of the Keel, and Breadth from the Outſide of the Ship on one Side, to the Outſide of the other; and multiplying that Breadth into the Length, and again by half the ſaid Breadth, and dividing the Product by 94, which is a general Rule to find the Tonnage.

I ſhall take the Length extream at the Height of the Gunnel in the Midſhips, on the Sheering Line, preſuming that the Value of the Work will ſwell according to the extream Length and Heighth of the Ship, and ſince the Length cannot be taken exact and genuine any higher it may be taken there.

Then I ſhall take the Girt in the Midſhips, from the Middle Line on to the Keel, to the Top-Timber Head of both Sides, and multiply that into the Length, which will give the Superficies of the Timbering and Planking, both within-ſide and without, near enough for our Purpoſe or Deſign: Then take the Length of the Lower-Deck, and Breadth at that Deck in the Midſhips, and multiply them one into another for the Superficies of the Deck, provided it was a Paralellogram; but ſince it is not I ſhall meaſure one Deck exact, and ſay, As the rough Superficies of that Deck is to the exact Superficies, ſo is the rough Superficies of any other Deck to the exact Superficies of the ſaid Deck.

Neither will it be found to matter much, the nicely obſerving two or three Feet of Plank, or 40 *or* 50 Trenels, or the boring a few Holes in working up a whole Ship, and therefore I ſhall not be ſo very tedious as to inſert every individual Piece of rough Work in ſo confuſed and perplexed an Obſervation.

And after the ſame manner may every Deck in the Ship, and Half-Decks be meaſured and taken in, as may be obſerved in the following Scheme.

For it muſt be undeniably allow'd, that the following Calculations is Prices that are as low as it's poſſible for Hands to comply with, and therefore whoſoever takes Work lower (without extraordinary Management) will be ſure to loſe conſiderably by it.——

But if the Goodneſs of the Work be ſet in ballance againſt the Diſpatch that's made by Hurrying and Driving of Men, and perhaps out of a Ship of two, three or four Hundred Tuns; they expect they ſave one or two Hundred Pounds in ſuch ſqueezing and bearing down the Workman in his Part, not minding that in Two or Three Years, or the firſt time the Ship comes to have a conſiderable Repair, their Charge ſhall be double that Sum more than what would be was the working Part nicely perform'd; and perhaps a total Expiration of the ſaid Ship three or four Years ſooner than ſhe would be, if ſhe had been well put together; ſo that there is the Uſe of a Ship loſt that at firſt coſt 2000 Pound ſo long, till the Uſe Money comes to double the Sum of what at firſt was reckon'd to be ſaved by ſuch Haggling: Without conſidering the extraordinary Charge that is made as often as ſhe comes into the Yard-Keeper's Hands, in the Term of fourteen or fifteen Years, or as long as ſhe laſts, with the Hazard that's run, and very often found, the Loſs of both Ship, Goods and Men, by ſuch Neglect.

A Three Deck Ship.

NOW comes in the Calculations, and firſt I ſhall begin with the largeſt Size, or one having Three Decks.

		Feet.			Feet.
Length of the	Lower Gun-Deck	170	Length of the	Quarter Deck	72
	Middle Deck	174		Forecaſtle Deck	36
	Upper Deck	175		Poop Deck	32

		Feet.	
Breadth in the Midſhips of the	Lower Gun-Deck	46	This is the Breadth at the Outſide of the Timbers.
	Middle Deck	43½	
	Upper Deck	38	

		Feet.	
Breadth at the Broadeſt Part of the	Quarter Deck	35	This is alſo to the Outſide of the Timber.
	Forecaſtle	36	
	Poop	32	

	Feet.
Length on the Sheering-Line, at the Gunnel in the Waſte.	177
Girt on the Timber in the Midſhips from the Middle Line. On the Keel to the Top Timbers Head of both ſides.	118

The Product of thoſe Parts, × one into another, is firſt 177, × by 118 is 20886. Then 46 × by 170 is 7820, 174 × by 43½ is 7559, 175 × by 38 is 6536, 72 by 35 is 2520, 36 by 36 is 1296, 32 by 32 is 1024.

The Dimenſions of a Deck of 165 Feet Length and 44 Broad, is 7260, and this Deck exactly meaſured produceth 4669 Feet 8 Inches, from which I find the Dimenſions of thoſe Decks to be as follows.

Dimenſions rough.	Lower Deck	7820 —— 5029	The Dimenſions exact enough for Practice.
	Middle	7559 —— 4840	
	Upper	6650 —— 4197	
	Quarter	2520 —— 1650	
	Forecaſtle	1296 —— 0825	
	Poop	1024 —— 0650	
Girt and Length on the Sheer.		20886 —— 20886	
	Total	—— 38077	

Which Sum of 38077 Feet = by 14, is $2719\frac{11}{14}$ *l.* or 15 *s.* 8 *d.* ½ which will be 32 *s.* 5 *d.* 1 *q.* per Tun, according to the Cuſtomary Method of meaſuring Ships. Then, for Brevity ſake, Note, that = ſhall ſtand for Dividing, × for Multiplying, Ft. for Feet, In. for Inches, ⊖ for Midſhips, D° for the ſame.

	l.	*s.*	*d.*
So that the whole Sum for Building ſuch a Ship is	2762	12	9$\frac{1}{2}$
The $\frac{1}{2}$ of the ſaid Sum ſhall be allow'd for Planking	1381	6	4$\frac{3}{4}$
The $\frac{1}{4}$ of the whole Sum for all the Decks	690	13	2$\frac{1}{4}$
The $\frac{1}{8}$ of the whole Sum for Timbering	345	6	7
And $\frac{1}{8}$ more for Finiſhing	345	6	7
Total	2762	12	9$\frac{1}{2}$

A Two Deck Ship.

NEXT is the Calculation of one of the largeſt Size, having Two Decks.

		Ft.		Ft.		Area.
Length of the	Lower Deck	150	Breadth of Dº.	39	Exact Dimenſions.	3750
	Upper Deck	153		36		3500
	Quarter Deck	62		32		1263
	Forecaſtle Deck	25		32		0510
	Poop	25		26		0416
Girt and Sheer.		155		36		13330
					Total	22769

Which Sum of 22769 divided by 15, gives 1517 *l.* 6 *s.* 8 *d.* which is the whole Sum for Building the Ship, and according to Cuſtom is 28 *s.* 6 *d. per* Tun.

	l.	*s.*	*d.*
The $\frac{1}{2}$ of that Sum is for Planking	758	13	4
$\frac{1}{4}$ of that Sum is for all the Decks	379	6	8
$\frac{1}{8}$ of the Sum is for the Timbering	189	13	4
$\frac{1}{8}$ of the Sum is for Finiſhing	189	13	4
Total	1517	6	8

Next is the Calculation of a Ship having one Deck.

		Ft.		Ft.		Area.
Length of the	Main Deck	96	Breadth of Dº.	23	Area Exact.	1400
	Quarter Deck	40		18		458
	Forecaſtle	15		18		172
	Sheer and Girt	97		56		5432
					Total	7462

Which Sum of 7462 = by 26, is 287 Pound, or according to Cuſtom 1 *l.* 1 *s.* 11 *d.* $\frac{1}{2}$ *per* Tun.

	l.	*s.*	*d.*
The half of 287 Pound for Planking is	143	10	0
The $\frac{1}{4}$ for all Decks is	71	15	0
The $\frac{1}{8}$ for Timbering is	35	17	6
The $\frac{1}{8}$ more for Finiſhing is	35	17	6
Total	287	0	0

Next is a Veſſel with half Decks of the largeſt Size.

				Area.
Length on the Sheer	53 Feet Girt both Sides at ⊖ 29 Feet		—— ——	1537
Length of the	Fore Part of the ½ Deck or Forecaſtle.	Ft. 18	Breadth 15 Feet ——	270
Length of the	Aft Part of the ½ Deck.	Ft. 20	Breadth 13 —— ——	260

Area Exact { 1537, 150, 166 } 1853 = by 33 is 56 Pound and $\frac{5}{33}$, or more than three Shillings.

1853 Which is 20 Shillings and $\frac{3}{56}$ parts of one Shilling

	l.	*s.*	*per* Tun.	*l.*	*s.*	*d.*	
To half	56	3	its ——	28	1	6	for Planking.
To ¼ it	——		——	14	0	9	for Decks.
To ⅛ it	——		——	7	0	4½	for Timbering.
For Finiſhing D°.	——		—	7	0	4½	
			Total	56	3	0	

Next comes in a Calculation for a Boat.

Length of the Boat on the Sheer—20 Feet, Breadth 6 Feet.
The Girt of both Sides —— 10 Ft. I allow ⅓ or 6 Ft 8 In. for Thwarts and Benches.
Length for Deck or Thwarts—6 F. 8 In. Area of 20 by 10 is 200
Breadth of the Boat —— —— 6 Ft. of 6 by 6--8, is 40
= 240 by 6 is 40 which ſhall be Shillings 240
For it will be found that the Working Part of Boats near this Size, will be ⅛ of the Value of the whole Boat.

Now the whole Sum for the Working Part being 40 *s.* the half for Boarding is 20 *s.* the ⅜ for Timbering is 7 *s.* 6 *d.* and the ⅜ for Thwarts and Benches is 7 *s.* 6 *d.* and the ⅛ for Finiſhing, is 5 *s.*

I ſhall farther obſerve that for every 10 Foot that any Two Deck Ship is ſhort of 150 long, the Diviſor ſhall riſe 2 ¾; as a Ship of 140 Foot long on the Gun Deck, the Diviſor ſhall be 17 ¾; for 130, Foot long 19 ½; for 120 Foot long 21 ¾, and there to ſtand till you come to a one Deck Ship. And now for the Diviſions and Sub-Diviſions.

Plank. It has been generally allowed, that the Plank within Board and without, from the Keel to the Top-Timber Head, is full, or very near half the Work, eſpecially in Bluff Ships, that are very Round, Forward and Aftward, which Parts require much Pains in bending the Planks by Burning. However, I ſhall put the Riders in with the Planking, to make it half in great Ships.

Decks. All the Decks and Platforms ſhall be ¼. ——

Timbering. The Timbering, including Keel, Stem, Stern-Poſt, Tranſums, Faſhion Pieces, Hawſe Pieces, Knight-Head Timbers, to Horn, Seg, Level and Shore, and Croſs-Pall ⅛.

Finiſhing. All Finiſhing Work, as Head, Stern, Galleries, Bulk-Heads, Ladders, Stairs, Gratings, Planſheers, Rails, Gang-ways, with all the Conveniences for the Standing and Running Rigging, as Blocks, Ranges, Kivels, Awning, if any, to be ⅛.

I ſhall firſt begin with the Planking, altho' the Timbering will firſt be wrought, however the Planking will be moſt material, and require, above all other Parts, to be done very nice, both within Board, and without Board; that is, by well Joyning and Faſtening, with even and fine Drawing every Plank, that the Ship may be equally ſtrong throughout the whole Frame.

Plank.

The Value of Working Strakes of Plank muſt be conſidered from the Bending, as well as from the Length, Breadth and Thickneſs.

Wales.

The Wales will require as much Time to work as three Strakes, altho' no thicker than two Strakes in ſome Ships, and has generally been allowed as two Strakes, but conſidering that they muſt be nicely trimmed with the Adze, ſo that it may be term'd twice wrought, alſo the Hinderance of Setting, to handſomly ſheer the Ship, and perhaps the Diſadvantage ſometimes of ſtaying for ſuch Timber, and making a ſtronger Stage, on purpoſe to bring the Wales upon.

Channel-Wales.

The Channel Wales, altho' as light as one of the Strakes, may go for two; from the ſame Obſervation of Trimming and Setting of them more nice than any other Strakes.

Above the Wale.

Ports.

Port-Cells.

Timbers ſpaced.

And all the Strakes above the Wale, altho' lighter and thinner than thoſe below the Wale, ſhall be at the ſame Price, provided that all the Ship Side above the Wale be lump'd together, and that the Ports are made by the ſame Hands; but if the Ports are made ſingle, then the Price may be allowed according to what they meaſure double, that is, if a Port be three Foot ſquare, reckon it at 18 Feet, beſides an Extra. Allowance, as much as the Difference is between that Plank, which is in the Wake of the ſaid Ports, and that Plank on the Ship's Bottom, provided that one Hand makes all the Ports on each Tire; but if not, the largeſt Ports to have the Allowance of the Upper Plank, and the Upper Ports to have the Allowance of the Lower Plank, or the Difference between the Value ſet, for the Plank in the Bottom, and that above the Wale to be changed to the contrary Ports; but this will only happen where there is three Tire of Ports. And Note, that when ſuch an Allowance is made, thoſe that make the Ports may put in the Port-Cells, or deduct the Charge of putting them in; which Port-Cells, to be put in by the Plankers, but the Timbers ought to be ſpaced to make the Ports, by the Timberers.

Within-Board Clamps:

Spirkit-riſing String.

Holes bored.

Trenels drove.

Wedging Trenels.

Next is within Board for Clamps, Sleepers, Spirkit-Riſing, Strings, and all in-Board Planking; and altho' our common Notion is, that the in-board Plank may be put out of hand rougher than that without, this, if rightly conſidered, will really appear perfect Fancy, eſpecially in great Ships; beſides, could it be allowed ſo, why, then the Pains requiſite would be found as much in one as the other, for altho' the Holes are all bored by the Out-board Hands, the Trenels are all drove by the In-board Hands: Nay, and all the Trenels drove out again that were at firſt Drove, and that alſo by thoſe that bring on the In-Board Plank, beſides wedging of Trenels; but what will moſt materially add to the Charge of working the inboard Planking is the Thickneſs of the ſaid Plank, more in it than in the other.

Gun Deck Clamps.

Orlop Clamps

The Clamps, from their extream Breadth and Thickneſs, being well fay'd and faſten'd, may be as valuable as three Strakes: Alſo the Orlop Clamps, or Middle Bands, from their binding the Work between the Gun Deck and Floor Timber Heads; obſerving that both theſe Clamps are well and proportionably ſcarfed with Hook and Butt.

Sleepers.

The thick Strakes of each Side the Floor, or Wrung Head Timbers to go for two, they being flat ſcarfed, that there may be but two Holes in the Room of four, with plain Buts, and all the other Strakes to go for one Equal to the Plank in the Bottom without-ſide.

Spirkit-riſing

The Two Strakes of Spirkit-riſing in a great Ship to go for Five, and in ſome Four, and others Two, according to the Diſproportion between them and the Bottom Plank, obſerving that the Care in Working the Spirkit-riſing will be equal to that under Water.

Clamps of the Middle Deck and Upper.

Clamps of every Deck to go for Two, alſo the Strings in the Waſte, from their being ſcored about the Timbers.

In the next Place I ſhall conſider what the Sort of Plank is worth Working, meaſured on the Superficies, and for an Information of which we muſt be beholding to Experience, which, in divers Caſes, will be allowed to be the beſt Schoolmaſter.

Out-board Plank.

But before I proceed, it will not be improper to conſider the general Cuſtom in Planking Ships Bottoms; which is that all out-board Planking, from the Keel to within three or four Strakes of the Wale is the ſame in a 60 Gun Ship, as it is in a Ship of 100 Guns, ſince there is little or no other Size cut, either between four and five Inches, or between three and four Inches; ſo that a great Part of a 50 Gun Ship is covered with four Inch Plank; when three Inch Plank and a half would be cheaper and much properer, for either ſhe, or a Ship carrying 60 Guns.

I have obſerved in the Publick Yards, that four Inch Plank has been wrought for five Pence *per* Foot under Water, meaſured on the Superficies, and then an Able Man has earn'd five Shillings *per* Day, the Men working from ſix to ſix; but then they worked very hard. And indeed in the Buſineſs of Ship-building, where the Miſcarriage of the Work lyes at the Pleaſure of every individual Journeyman, and alſo that by extra-ſtraining Men will require a double Recruit to ſupport Nature, and alſo the Hazard a Man runs in diſmembring himſelf by ſuch Over-haſte, he really, and in all Reaſon, deſerves double Wages.

However, I will make my Proportion by allowing four Pence *per* Foot for four Inch Plank, well wrought and faſtened, which is meant under Water; and whether Stuff eight Inches thick, will require eight Pence *per* Foot, or double as much, I ſhall conſider as follows.

In the firſt Place, an eight Inch Plank that is of equal Length and Breadth to one four Inches thick, will be juſt double as heavy, and will require double as much Help to bear it to it's Work, and alſo double ſupport to keep it there; ſo that the Proviſions muſt be juſt twice as large in the one as in the other; the Holes will be alſo double as long, and will require near twice the Time to bore, the ſame will be in the Trenels; but however the double Drift of faſtening will be only in the Plank, for in the Timber that holds the Plank it will be equal, or ſometimes leſs in the eight Inch than in the four Inch upon the ſame Ship. However, conſidering the Boring of Holes when an Augre is entered, will not counter-ballance the Trouble that often happens in ſuch thick Plank, with the Care that ought to be in well performing of it. Beſides altho' the eight Inch Stuff be but twice as thick and heavy as 4 Inch Plank of equal Length and Breadth, it will be four Times as ſtrong, and will require a Purchaſe, equal to the Strength to bend it, and from ſuch Conſiderations it will follow, that eight Inch Stuff will be twice as chargeable to work, as four Inch Plank, which Proportions will be as follows.

A Table of the Price or Value of Working divers Sorts of Plank.

Size.		Price.		Size.		Price.	
1½	Inches thick.	2	Pence and Feet.	6	Inches thick.	6	Pence *per* Feet.
2		2½		7		7	
3		3		8		8	
4		4		9		9	
5		5		10		10	

In Conſideration that the Trouble of Spileing a little Plank will be near equal as much as to Spile a great One, I have advanced two Farthings *per* Feet, in one and a half Inch, and two Inch Plank; and this Method will be ſufficient to adjuſt the Number of Strakes there will be in ſuch a great Ship; tho' the faireſt Way will be to exactly meaſure the Superficies, and adjuſt the Price that Way.

However, I ſhall procceed to ſhew what Number of Strakes there will be requiſite in the ſaid ſeveral Sizes of Ships, as aforeſaid.

The Number of Strakes requiſite on Board a Ship of Three Decks, Length of the Lower Deck 170 Feet.

Without Board.		Within Board.	
Under the Wale and Above the Wale.		Under the Lower Gun Deck.	
Of 18 In. Broad 8; 4 of them	Strakes.	Gun Deck Clamps 2 to	Strakes.
To go for 8, that the Number is,	12	go for	6
Of 16 In. broad, 8	8	Orlop Clamps 2 Dº.	6
Of 14 In. broad, 8	8	Sleepers 18 Dº.	36
Of 12 In. broad, 2	2	Other Strakes 4 Dº.	4
Double Wales 2 to go for	8	Upon the Lower Deck.	
Between the Wales 2 Dº.	4	Spirkit-riſing, 2 Strakes Dº.	5
Channel Wales 4 Dº.	8	Clamps, 1 Dº.	2
Above the Wales. } 4 of 16 In. Broad.	4	Between them 3 Dº.	3
9 of 12.	9	Upon the Middle Deck.	
	——	Spirkit riſing, 2 Dº.	4
	63	Clamps, 1 Dº.	2
	76	Between 2 Dº.	2
	——	Upon the Upper Deck.	
	139	Spirkit-riſing, 2	2
	——	String, 1 to be	2
Both Sides Total	278	Between 2 Dº.	2
			——
Value of one Strake of Plank on ſuch a Ship is 4 *l.* 14 *s.* 3¼. Working.		Total	76

Value of a Strake of Plank on a First Rate.

The Number of Strakes requiſite on Board a Ship having Two Decks, Length of the Lower Deck 150 Foot.

Without Board.		Within Board.	
Under the Wale and Above the Wale.		Under the Lower Deck.	
Of 16 In. broad, 8; 3 of them	Strakes.		Strakes.
to go for 6, the Number is	11	Two Clamps for the Gun Deck	5
Of 15 In. 8	8	Dº. for the Orlop	5
Of 14 In. 7	7	Sleepers, 15 reckon'd	30
One double Wale reckon'd	4	And of other Strakes	4
One ſingle Wale as	3	Above the Lower Deck.	
A Strake between	2	Spirkit-riſing, 2 reckon'd	4
Above the Wale.		Clamps 1 Dº.	2
Of 14 In. broad	4	Between 2	2
Channel Wale, 2 reckon'd as	4	On the Upper Deck.	
Of 11 In. broad 6	6	Spirkit-riſing 2	2
	——	String 1	2
Total Strakes.	49	Between 2	2
	58		
	——	Total Strakes	58
	107		
Both Sides	214	Value of one Strake of Plank on ſuch a Ship is 3 *l.* 8 *s.* Working.	

Value of a Strake of Plank on a Third Rate.

On a Sixth Rate.

Strakes under the Wale on a one Deck Ship whoſe Length is 96 Ft.		Strakes Within Board on ſuch a Ship.	
Of 14 In.--8, and of 12 In. broad, 6	14	Clamps, 2 on the Gun-Deck, and 2 for the Orlop reckon'd.	6
Wales 2, reckoned as	4	Sleepers, 3 reckon'd as	4
Between the Wale	1	Other Strakes 6	6
Above the Wale 8 of 10 In.	8	Above the Deck.	
Total	27	Spirkit-riſing 2 Strakes	2
		String 1 D°.	2
Value of one Strake of Plank on ſuch a Ship is 1 *l.* 7 *s.* 6 *d.* Working.		Between 2 D°.	2
		Total	22
		Total both Sides 98	27
			49

The Number of Strakes requiſite on a Half Deck Veſſel, Length 53 *Feet:*

Of 11 Inch broad, N°. 10 under Water, or under the Wale ——	10
One Wale reckon'd as two Strakes, and 5 of 10 In. above the Wale —	7
Under the Deck the Clamp as two, and 8 other Strakes —— ——	10
Upon Deck —— —— ——	3
Total	30
Both Sides	60

On a Veſſel of 53 Feet long.

Value of one Strake of Plank on ſuch a Veſſel is 9 *s.* 4 *d.* Working.

On a Boat.

Number of Strakes on a Boat of 20 Feet long —— —— 6

Three of 11 Inches broad, one of 10 Inches, one of 9 Inches, and one of 8 Inches broad.

Both Sides 12

Value of one Strake of Board on ſuch a Boat is 1 *s.* 8 *d.* Working.

And now for Dividing the Planking Money; which in a Three Deck Ship is 1381 *l.* 6 *s.* 4 *d.* ¾. and for a Two Deck Ship it's 758 *l.* 13 *s.* 4 *d.* and for a One Deck Ship its 143 *l.* 10 *s.* and for a Half Deck Ship 28 *l.* 1 *s.* 6 *d.* and for a Boat it's 20 *s.*

Firſt, I take the Charge of Fixing all the Riders out of each Sum, according to the Number of Riders in each Ship.

Number of the Riders in a great Ship. The Number in ſuch a Three Deck Ship of 170 Foot long will be 45, that is 9 Floor Riders, and 36 Foot Hook Riders.

Charge of the Riders. Now if two Able Men, and each having a Servant, can get in and fix a Bend of ſuch Riders in 12 Days, at 13 *s. per* Day, the Money will come to 69 *l.* 15 *s.* = 48, the Ship's Breadth, by 1--38, for the fixing each Floor Rider, and = 48 by 1--6, for fixing each Foot hook Rider; then × the 48 by 1--43 for the whole Charge, which is 69 *l* 15 *s.*

Floor Riders at 35 *s.* each. —— Foot-hook at — 30 *s.* each. ——	Subſtract 69 *l.* 15 *s.* from 1381 *l.* 6 *s.* 4 *d.* ¾. Remains 1311 *l.* 11 *s.* 4 *d.* ¾. for Planking, which = by 278, the Number of Strakes, is 4 *l.* 14 *s.* 3 *d.* ¼ each Strake of 4 In. and a Half Plank.

Number of Riders in a Third Rate. On a Ship 150 Foot long, the Riders will be 6 Bends, or 30 Riders, at 28 *s.* a Floor Rider, and 22 *s.* a Foot-hook Rider; the whole Charge is 31 *l.* which

Subſtracted from 758*l.* 13*s.* 4*d.* Remains 737*l.* 13*s.* 4*d.* = by 214, the Number of Strakes is 3*l.* 8*s.* each of them. Then = 40 the Breadth by 1--3 gives the whole Sum. = 40 by 1--43 for the Floor Riders, and by 2--91 for the Foot-hook Riders.

	l.	*s.*
= 40 by 1--3 for the whole Sum of the Riders, or ———	31	0
= 40 by 1--43 for the Floor Riders ——— ———	1	8
= 40 by 2--91 for the Foot-hook Riders ——— ———	1	2

Number in a Sixth Rate. Charge of the Riders.

In a Ship of 96 Ft. long, the Riders will be 3 Bends, or 9 Riders, having but one Tire of Foot-hook Riders. = 24, the Breadth, by 2--86, for the whole Charge, or 2*l.* 16*s.* 3*d.* which ſubſtracted from 143*l.* 10*s.* remains 8*l.* 8*s.* 9*d.* = by 98 the Number of Strakes is 1*l.* 7*s.* 6*d.* each Strake. Then = the Breadth by 2--3 for the Floor Riders, and by 2--91 for the Foot-hook Riders.

A Ship or Veſſel of 53 Foot long, the Money allowed for Planking will be 28*l.* 1*s.* 6*d.* = by 60 the Number of Strakes is 9*s.* 6*d.* each Strake.

A Boat of 20 Feet long, the Money for Boarding is 20*s*, = by 12 it's 1*s.* 8*d.* each Strake.

Notwithſtanding theſe Calculations are not to oblige Men of one Side, or another, to make Bargains nicely or exactly from the Rules mentioned, but only to bring Prices ſomething near a General Proportion, that from thence any Man may venture to lump his Work, and be aſſured not to loſe or gain in any Extream.

Beſides, it will be farther allowed, that Work may be done much Cheaper at one Time of the Year than at another, having a Regard to the Goodneſs and Fitneſs of Stuff, to the Conveniency of the Place you Work in, alſo to the Seaſon of the Year, as in all Likelihood Spring and Autumn is the beſt.

Alſo that the Maſter that employs Men be Proof, that Men run no Hazard, but may boldly, and with good Hearts, ſtand by their Work, having a good Aſſurance of being well paid, when they have perform'd their Labour.

Alſo that the Labourers be Men capable to perform, and not ſpoil the Maſter's Timber, Men of ſome Credit and Reputation, not Shifters, or thoſe that for Idleneſs or Fancy ſhall leave a Yard Keeper's Buſineſs, when he has moſt Occaſion, and when perhaps he lyes under ſome Penalty for his Performance.

All which Cautions being duly conſidered, any Man may proceed from ſuch Rules as are here inſerted, and be ſafe.

A Ship of 170 Foot long on the Deck.

A Three Deck Ship's Timbering.

In the next Place I come to the Timbering, or getting up the Frame; in order thereto I ſhall = that Part into three Principals: The Firſt is to lay the Ways (not Ground Ways, for that ought to be Part of the Yard) to fit the Keel, Falſe Keel, Stem and Falſe Stem, Poſt, Falſe Poſts, Tranſums and Half Tranſums, Faſhion Pieces, Dead-Wood, Afore and Abaft with the Knee, and to get all up in their Places, and to ſecure them in Workmanlike Manner, ſhall be ⅓ of the Whole, or 115*l.* 2*s.* 2*d.* ¼.

Charge of the Keel, &c.

Then I ſhall again ſubdivide this Part into three other Parts. Firſt, to Trim and Scarph the Main Keel to Rabbet him, and put on the Falſe Keel, to lay the Ways, and put on the Splitting Blocks, and put on the Keel, and ſcore him down into thoſe Splitting Blocks, ſhall be ⅓ of 115*l.* 2*s.* 2*d.* ¼. or 38*l.* 7*s.* 4*d.* ¾. Secondly, To fit the Stem, the Falſe Stem, Rabbet him, to get on the Dead-Wood Foreward, and the Knee Aft, to raiſe the Stem and ſet him right with the Keel, and faſten all the ſaid Parts, another ⅓ Part, or 38*l.* 7*s.* 4*d.* ¾. *Stem.*

Stern Poſt. Tranſums. Faſhion-Pieces.

Thirdly, To fit the Stern Poſt, with Falſe Poſts, Tranſums of either Sort, and Faſhion Pieces, to raiſe them, and level them with the Middle Line on the Keel, and to get on the Dead-Wood Aſt, is the other ⅓ Part, or 38 *l.* 7 *s.* 4 *d.* ¾, obſerving to ſecure them all very well with Shores.

The next principal Part of Timbering is the Floor Timbers, Half Timbers, and Kelſon, which I ſhall again ſubdivide; and ſince there will be in ſuch a great Ship 50 Floor Timbers, and 12 Half Timbers, and in allowing that two Half Timbers ſhall be equal in Work to one Floor Timbers, I ſhall ſet them down as 56 Floor Timbers; from which it will follow that Fitting all the Floor Timbers and Choking of them, cutting the Limber Holes, with Letting in the Half Timbers, and Faſtening of them all will be ⅔ of 115 *l.* 2 *s.* 2 *d.* ¼, or 76 *l.* 14 *s.* 9 *d.* ½.

Floor-Timbers.

Kelſon.

Then to bolt all the Floor Timbers, to get in the Kelſon, to fit and faſten him, to Ribbon the Floor, and level it and ſhore it well, ⅓, or 38 *l.* 7 *s.* 4 *d.* ¾.

Now to ſubdivide the Floor Timbers to know every one's particular Charge, will be difficult, by Reaſon of the Variety of Matter that may be required in one more than in another; altho' I muſt needs be of the Opinion that it will be very ill Huſbandry to have ſuch large Timbers without Breeches or Choks to give them their Riſing, but ſtill the Breeches in one Timber may be very large to what it may be in another; ſo that the propereſt Method will be to ſee the Bigneſs of the Choks, and the Handineſs of getting them before you Lump one, or any particular Number of them.

However, to come as near as poſſible in this Part, and to give as near a Light as may be into the Value of every particular Floor Timber; I ſhall firſt = the Sum of 76 *l.* 14 *s.* 9 *d.* ½ by 56, and it's 1 *l.* 7 *s.* 4 *d.* each.

But obſerving that there is near twice the Work in an Aftermoſt or Foremoſt Floor Timber as there is in the ⊖, I ſhall divide them by leſſening the ⊖ Timbers to 22 *s.* ſo that the eight ⊖ Timbers ſhall be equal, and alſo the ſix Pair of Half Timbers, which make 14 of 56; then ſucceſſively proceed by taking 4 and ¼ Timbers, from the ⊖ Aft and Forward till you come quite to the Extreams of the Riſing Timbers, allowing every Eight to be of equal Price; ſetting them down as follows.

The Timbers Alphabetically and Figuratively Numbered.			Value of each.			Value of the Whole.		
6 Pair of Half Timbers and 8 ⊖ Timbers			*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
8	a, b, c, d,	1, 2, 3, 4,	1,	2,	0,	15,	8,	0,
8	e, f, g, h,	5, 6, 7, 8,	1,	5,	4,	10,	2,	8,
8	i, k, l, m,	9, 10, 11, 12,	1,	7,	7,	11,	0,	6,
8	n, o, p, q,	13, 14, 15, 16,	1,	9,	11,	11,	19,	4,
8	r, s, t, u,	17, 18, 19, 20,	1,	12,	0,	12,	16,	0,
10	21, 22, 23, 24,	25, 26, 27, 28.	1,	13,	10,	13,	10,	8,
					Total	74,	17,	2,
						76,	14,	9 ½
					Too much	2,	7,	7 ½

Allowing 22 Floor Timbers, ⊖ Timber included, forward, and 28 abaft ⊖, beſides the 6 Half Timbers.

And now I come to the Subdiviſions of the other Part of the Frame, which conſiſts of Lower Foot-hooks, ſecond Foot-hooks, third Foot-hooks, fourth Foot-hooks, and Top-Timbers; Hawſe-Pieces, Knight-Head Timbers, all long Timbers Afore, with Falſe Harpins, Ribbons, Corner Counter-Timbers, to ſpace the Ports, and put up all the ſhort Timbers over the Ports, to Horn, Level and Croſs-Pall: Alſo to ſhore all the Frame very ſecure, and perfect the Timbering and Choking in every Reſpect, and the Sum allowed is 115 *l.* 2 *s.* 2 *d* ½. Then the Subdiviſion will be as follows.

To Frame the Timbers:

Firſt, To Frame the Timbers by putting the Foot-hook and Top-Timbers together, as Cuſtome, to get all the Frames up, to Horn, Level, Croſs-Pall, Ribbon, Falſe Harpins, and ſecurely Shoreing them; or 57 *l.* 11 *s.* 1 *d.*

And ſince that there is in ſuch a Ship 42 Frames, = 57 *l.* 11 *s.* 1 *d.* by 42, and it's 1 *l.* 7 *s.* 4 *d.* ½ each Frame.

Other Part of the Frame.

I ſhall = the other Half into 6 Parts, making the Choking, Trimming, and getting in the Lower and Second Foot-Hooks one ſixth Part: Then the getting in the Third and Fourth Foot-Hooks and Top-Timbers ⅙: The Falſe Harpins, Long Timbers Forward, and Shoring them ⅙: The Hawſe-Pieces, and Knight-Head Timbers ⅙: The Filling in all the Timbers between the Aftermoſt Frames and Counter Corner Timbers ⅙; with the Choks between the Faſhion Pieces and Stern Poſt. Then putting up all the ſhort Timbers over the Ports, and ſpacing all the Ports, and perfecting all the Wants ⅙. So that = 57 *l.* 11 *s.* 1 *d.* by 6, it is 9 *l.* 11 *s.* 10 *d.* for each Part, and ſo is ſuch a Ship's Timbering finiſhed.

Next I come to the Calculation of a Ship of 150 Foot long on the Gun Deck.

For a Two Deck Ship's Timbering.

The Money allowed for Timbering ſuch a Ship is 189 *l.* 13 *s.* 4 *d.* which = by 3, is 63 *l.* 4 *s.* 5 *d.* ¼: And 63 *l.* 4 *s.* 5 *d.* ¼ = by 3, is 21 *l.* 1 *s.* 5 *d.* ¾. Now, for Brevity ſake, I ſhall only mention the Heads of every principal Part, and refer you to the preceeding Calculations for the Particulars.

	l.	*s.*	*d.*	
Then for Fitting the Keel, and Laying the Ways ———	21	1	5 ¾	*Keel.*
For the Stem, *&c.* ——— ——— ———	21	1	5 ¾	*Stem.*
For the Stern Poſt, Tranſums, *&c.* ——— ———	21	1	5 ¾	*Stern Poſt.*
For the Floor Timbers, *&c.* ——— ——— ———	42	2	11 ½	*Floor.*
For the Kelſon, *&c.* ——— ——— ———	21	1	5 ¾	*Kelſon.*
For the Frames ——— ——— ———	31	12	2 ½	*Frames.*
For the other Six Particulars ——— ——— ———	31	12	2 ½	

In ſuch a Ship there will be three Floor Timbers leſs than in a Three Deck Ship, and I ſhall leave them out in the Midſhips; ſo that there will be 53 Floor and Half Timbers together. Then = 42 *l.* 2 *s.* 11 *d.* ½, by 53 it's 15 *s.* 10 *d.* each, if the Work was equal; but ſince they are not I ſhall make a Calculation, as follows.

Each Floor Timber.

The Timbers Alphabetically and Figuratively Numbered.			Value of each. *l.*	*s.*	*d.*	Value of the Whole. *l.*	*s.*	*d.*
6 Pair of Half Timbers and 5 ⊖ Timbers;								
5	a, b, ———	1, 2, 3, ———	——— 0	12	6	——— 6	17	6
8	c, d, e, f, —	4, 5, 6, 7, ———	——— 0	14	4	——— 5	14	8
8	g, h, i, k, —	8, 9, 10, 11, ———	——— 0	15	7	——— 6	4	6
8	l, m, n, o, —	12, 13, 14, 15, ———	——— 0	16	10	——— 6	14	9
8	p, q, r, s, —	16, 17, 18, 19, ———	——— 0	18	0	——— 7	4	0
8	t, u, 20, 21, —	22, 23, 24, 25, ———	——— 0	19	0	——— 7	12	0
						40	7	5
						42	2	11½
						01	15	6½

Allowing 20 Floor Timbers Forward, ⊖ included, and 27 Aft, beſides 6 Pair of Half Timbers.

Charge of the Frames.

Then there being 41 Frames = 31 *l.* 12 *s.* 2 *d.* ½, by 41, it's 15 *l.* 5 *s.* 2 *d.* each Frame. Then = 31 *l.* 12 *s.* 2 *d.* ½, by 6, it's 5 *l.* 5 *s.* 8 *d.* for each of the other 6 Particulars: As for the Lower and Second Foot-Hooks, Third and Fourth Foot hooks and Top-Timbers, Falſe Harpings and Long Timbers, Hawſe-Pieces and Knight-Head Timbers, ſhort Timbers about the Faſhion Pieces and Corner Timbers, Spacing the Ports and Compleating, and the Ship of 150 Foot long is finiſhed.

A One Deck Ship's Timbering. Now for the Timbering a Ship with one Deck, 96 Foot long on the Gun-Deck, the whole Money is 35 *l.* 17 *s.* 6 *d.* = by 3, it's 11 *l.* 19 *s.* 2 *d.* = 11 *l.* 19 *s.* 2 *d.* by 3, it's 3 *l.* 19 *s.* 8 *d.* $\frac{1}{2}$.

		l.	*s.*	*d.*
	For Fitting the Keel and Laying the Ways	3	19	8 $\frac{1}{4}$
Keel.	For the Stem, *&c.*	3	19	8 $\frac{3}{4}$
Stem.	For the Stern Post, Transums, *&c.*	3	19	8 $\frac{1}{2}$
Stern Post.	For the Floor Timbers, *&c.*	7	19	5
Floor.	For the Kelson, *&c.*	3	19	8 $\frac{3}{4}$
Kelson.	For the Frames, *&c.*	5	19	7
Frames.	For the other Six Particulars	5	19	7

In such a Ship there will be 40 Floor Timbers, and 3 Half Timbers on each Side: The Calculation will be as follows, observing that there will be but one Θ.

Each Floor Timber.

The Timbers Alphabetically and Figuratively Numbered.			Value of each. *l.*	*s.*	*d.*	Value of the Whole. *l.*	*s.*	*d.*
3	Pair of $\frac{1}{2}$ Timbers and 1 Θ Timber		0	2	8	0	10	8
8	a, b, c, d,	1, 2, 3, 4,	0	3	0	1	4	0
8	e, f, g, h,	5, 6, 7, 8,	0	3	3	1	6	0
8	i, k, l, m,	9, 10, 11, 12,	0	3	6	1	8	0
8	n, o, p, q,	13, 14, 15, 16,	0	3	9	1	10	0
7	17 18 19	20, 21, 22, 23,	0	4	1 $\frac{1}{2}$	1	8	7

Charge of the Frames. The Sum by Calculation is 7 *l.* 7 *s.* 3 *d.* Substracted from 7 *l.* 19 *s.* 5 *d.* Remains 12 *s.* 2 *d.*

Then there will be 30 Frames, = 5 *l.* 19 *s.* 7 *d.* it's 3 *l.* 11 *d.* $\frac{1}{2}$ each: and for the other Part, since there will be no Third nor Fourth Foot-Hooks, I shall Divide it into 5 Parts; as Lower and Upper Foot-hooks, $\frac{1}{5}$; False Harpings and Long Timbers $\frac{1}{5}$; Hawse Peces and Knight-Head Timbers $\frac{1}{5}$; Top Timbers and Perfecting the Timbering $\frac{2}{5}$; then = 5 *l.* 19 *s.* 7 *d.* by 5 and it's 1 *l.* 3 *s.* 11 *d.* each.

A Half Deck Ship's Timbering. Then for a Ship with a Half Deck, Length 53 Foot, the whole Sum for Timbering is 7 *l.* 0 *s.* 4 *d.* $\frac{1}{2}$. = it by 3 it is 2 *l.* 6 *s.* 9 *d.* $\frac{1}{2}$ = 2 *l.* 6 *s.* 9 *d.* $\frac{1}{2}$ by 3. it's 15 *s.* 7 *d.*

		s.	*d.*
	For Fitting the Keel and laying the Ways	15	7
Keel.	For the Stem, *&c.*	15	7
Stem.	For the Post and Transums, *&c.*	15	7
Stern Post	For the Floor Timbers, *&c.*	31	2
Floors.	For the Kelson, *&c.*	15	7
Kelson.	For the Frames, *&c.*	23	4 $\frac{3}{4}$
Frames.	For the other Parts	23	4 $\frac{3}{4}$

In such a Vessel there will be 30 Floor Timbers, and 3 Half Timbers on each Side, and but one Θ.

Each Floor Timber.

The Timbers Alphabetically and Figuratively Numbered.			Value of each. *s.*	*d*	Value of the Whole. *l.*	*s.*	*d.*
3	Pair of $\frac{1}{2}$ Timbers, and one Θ Timber		0	9	0	3	0
8	a, b, c, d,	1, 2, 3, 4,	0	10 $\frac{1}{4}$	0	6	10
8	e, f, g, h,	5, 6, 7, 8,	0	11 $\frac{1}{4}$	0	7	10
8	i, k, l, m,	9, 10, 11, 12,	1	0	0	8	0
5	13,	14, 15, 16, 17,	1	0 $\frac{3}{4}$	0	5	3 $\frac{3}{4}$
					1	10	11 $\frac{1}{2}$

There will be 26 Frames, = 23 *s.* 4 *d.* ¾, by 26, and it's 10 *d.* ¾ each. Divide the 23 *s.* 4 *d.* ¾ by 5, and it's 4 *s.* 6 *d.* for each of the other Parts, which for the Particulars I refer you to the Ship of one Deck, 96 Foot long.

Three Deck Ship.

In the next Place I come to the Decks, which I ſhall Divide and Subdivide as follows. In a Three Deck Ship I ſhall make 5 Diviſions, as Orlop or Platform, Lower Gun Deck, Middle Deck, Upper Deck, Quarter Deck, Forecaſtle Deck, Poop Deck: Then to make of theſe 5 equal Diviſions, I proceed thus,

The Trimming, Scarfing, and getting in the Lower Deck Beams, Kneeing them, putting in the Carlings and Ledges, to lay the Flat of the Deck with Plank of Four Inch and a half Thick, with the Water Ways, and Making the Hatches will be ⅕ of the Whole, or 138 *l.* 5 *s.* 3 *d.* I ſhall again ſubdivide it into 5 other Parts, which is to get the Beams Scarphed, Trim'd, and let them down into the Clamps ⅕, or 27 *l.* 13 *s.*

To Knee them ⅕, to put in Carlins and Ledges, and Partner of Maſts and Capſtands, with the Step of the Jeer Capſtand ⅕. Then to lay the Flat of the Deck Water Ways, and to make all the Hatches ⅖, or 57 *l.* 6 *s.*

First, To the Beams, if there is 25, and all of equal Value, it's but Dividing 27 *l.* 13 *s.* by 25, and it gives the Charge of each particular Beam, which would be 22 *s.* 1 *d.* each Beam; but it's very probable that the Θ Beams will be near twice as much Work as the Foremoſt and Aftermoſt, and not only from their extream Length, more in the Middle of the Ship, than at the Extreams, but ſuch long Beams are generally made in Two Pieces, and ſometimes in Three; from which I ſhall allow that the Foremoſt and Aftermoſt Beam ſhall be of equal Value to Work, and ſo ſucceſſively take two Beams, one Afore and one Abaft, and allow them to be equal in Value, till I come to the Middle Beam.

Value of the Beams Numbering of them 1 Forward and one Aft.		Single each.			Together both		
		l.	*s.*	*d.*	*l.*	*s.*	*d.*
Forward 1	Aft —— 1	0	12	6	1	5	0
D°. —— 2	D°. —— 2	0	16	0	1	12	0
D°. —— 3	D°. —— 3	0	18	0	1	16	0
D°. —— 4	D°. —— 4	1	0	0	2	0	0
D°. —— 5	D°. —— 5	1	1	6	2	3	0
D°. —— 6	D°. —— 6	1	2	9	2	5	6
D°. —— 7	D°. —— 7	1	3	9	2	7	6
D°. —— 8	D°. —— 8	1	4	9	2	9	6
D°. —— 9	D°. —— 9	1	5	7½	2	11	3
D°. —— 10	D°. —— 10	1	6	6	2	13	0
D°. —— 11	D°. —— 11	1	7	4	2	14	8
D°. —— 12	D°. —— 12	1	8	1½	2	16	3
Θ Making.	25 ——	1	8	10½	1	8	10½
			Total		29	2	6½
					27	13	0
			Too much		1	9	6½

Lower Deck Beams.

There appears by the Calculations 1 *l.* 9 *s.* 6 *d.* ½, more than the Sum allowed which may be adjuſted in making the Bargain.

These Beams are to be double Knee'd which will be 100.

Knees.

Then = the Sum of 27 *l.* 13 *s.* by 100, it's 5 *s.* 6 *d.* for the Fixing each Knee.

Carlings and Ledges.

Then for the Carlings and Ledges, I ſhall = the Rooms after the ſame Manner as the Beams was valued; but obſerving that there will be one Room more of Carlings and Ledges than there is Beams.

Value

Carlings and Ledges.

Value of the Carlings and Ledges Calculated by the Rooms, taking one Aſt and one Afore, and proceeding to the Midſhips.

	l.	*s.*	*d.*			*l.*	*s.*	*d.*
For Two Rooms.	0	18	0		For Two Rooms.	1	18	0
D°.	1	3	6	10 1 7	D°.	1	19	6
D°.	1	6	9	12 7 3	D°.	2	0	10
D°.	1	10	0		D°.	2	2	0
D°.	1	12	6	22 8 10	D°.	2	3	0
D°.	1	14	6	27 13 0	D°.	2	3	11
D°.	1	16	4		D°.			
				05 4 2	D°. Total	12	7	3
Total	10	1	7					

The Calculations for the Carlings and Ledges is 22 *l.* 8 *s.* 10 *d.* which taken from 27 *l.* 13 *s.* is 5 *l.* 4 *s.* 2 *d.* which will pay the Charge of getting in the Partners of Maſts and Capſtands, and Step of the Jeer Capſtand, which = by 4 will be 1 *l.* 6 *s.* 0 *d.* ½ for Dividing the Mizen Partners; and put one Part to the Partners of the Foremaſt, and the other Part to the Partners of the Main Capſtand, it will make them equal to the Partners of the Main Maſt, and Step of the Jeer Capſtand.

Partners of Maſts and Capſtands.

Particular Price of Carlings and Ledges.

As to the particular Price of the Carlings and Ledges, I firſt conſider that the Carlings are as ſquare as four Ledges, and from which it may be expected, are in Value accordingly. But ſince every Ledge requires to be ſingly pricked, and alſo obſerving the Trouble that often happens in letting down Ledges in the Wake of the Knee Bolts; I ſhall allow them as three to one, there being in the Midſhip Rooms between Beam and Beam, ſix Carlings, and between every two Carlings four Ledges. So that the Number, according to the preceeding Allowance is 46 one with another in each Room, that is 92 in two Rooms, and the Money for the ſame is 2 *l.* 3 *s.* 11 *d.* that it's near ſix Pence a Piece for each Ledge, and eighteen Pence each Carling; and in conſideration of the Curioſity of the Work requiſite in thoſe Parts, they being Principal Props in ſtrengthening the Main Beams of the Fabrick, they will be worth as much nicely performed.

Flat of the Deck.

Then for the Flat of the Decks, it's $\frac{2}{5}$, or 55 *l.* 6 *s* and if this Deck was to be laid by the Foot it would be worth 2 *d.* ½ *per* Foot, and not 4 *d.* ½, as the Out-board Plank is, by reaſon that there is no Holes to bore of ſuch Lengths, nor Trenels to drive of half the Drift, as the Out-board Plank has. Neither is there any Bending by Fire, or Stage to make: The Deck meaſured on the Superficies is 5029 Foot, at 2½ *d.* *per* Foot 52 *l.* 7 *s.* 8 *d.* So that there will be 2 *l.* 18 *s.* 4 *d.* for the Extra Work that will be in the Water Ways.

Water-Ways

Orlop.

Next I come to the Orlop or Platforms, which conſiſts of 12 Beams, every way as chargeable as the Midſhip Beams on the Gun-Deck. Theſe Beams are likewiſe to be double Knee'd. To lay the whole Platform with Carlings and Ledges, and Inch Oak Board; to build all Conveniences for Stores and Dry Proviſions; to fix all Standers on the Gun-Deck and Croſs Pillars, and other Pillars; and Step of the Main Capſtand, with Shot-Lockers, and Part of the Well; the Money for doing it is 138 *l.* 5 *s.* 3 *d.* Which Part I ſhall ſubdivide into Four, which is 34 *l.* 11 *s.* 3 *d.* ¾.

But by the Way, I ſhall obſerve there will be a ſtrong and a ſubſtantial Stage required to be made for the Conveniency of getting the Orlop Beams in upon, and the Charge of making ſuch a Stage, ſhall be Part of the Charge of this ſaid Particular.

Orlop Stage.

Then = the Breadth of the Ship by 4, ſhall give the Charge of Making this Stage, or 12 *l.*

The Firſt of the Four Parts ſhall be to get the Beames Scarfed, Trimm'd, and in their Places, to Knee them, to fix Fourteen Standers on the Lower

Deck, and Eighteen Croſs Pillars in the Hold, the Sum allowed will be, 34 *l.* 11 *s.* 3 *d.* ¾.

N°.		*l.*	*s.*	*d.*		*l.*	*s.*	*d.*	
12	Gun-Deck Beams	1	8	10 ½	*per* Beam is	17	6	6	*Beams.*
24	Knees at	0	5	6	each is	6	12	0	*Knees.*
14	Standers at	0	6	0	each is	4	4	0	*Standers.*
18	Croſs Pillars at	0	5	0	each is	4	10	0	*Gun-Deck. Croſs Pillars.*
						32	12	6	
						34	11	3 ¾	

l. *s.* *d.*
So that here is 1 18 9 ¾ more in the general Allowance than the Particulars riſes to — — — 1 18 9 ¾

The next ¼ Part is the Carlings and Ledges of the Platform, between the Store Rooms Afore and Abaſt, to lay the ſaid Part with one Inch Board; to put up all the Pillars, Step of the Main Capſtand, Shot-Lockers, and Part of the Well, the Sum is 34 *l.* 11 *s.* 3 *d.* ¾.

Carlings and Ledges, and Flat.

There will be 25 Pillars = the Depth in the Hold by 6 -- 5

Pillars.

l. *s.*
its 3 *s.* each, or — — — 3 15
For the Step of the Capſtand = the Depth, it is 6 — = by 3 -- 3
Shot-Locker, and Aft Part of the Well × the Depth by 2 it's — — — } 1 19 2

Step of the Main Capſtand.
Shot Lockers

The Carlings and Ledges will be valuable to the Gun-Deck Carlings, as they are in Proportion one to another. The Flat laying with Inch Board will be worth 1 *d.* *per* Foot, for all the Beams will be Rabbetted to Encreaſe Height.

Flat.

I come next to the Store Rooms, Afore and Abaſt, which will be near equal one to another; tho' ſuch Parts are variouſly built, either according to the Fancy of the Builder, or the Officers which belong to ſuch Rooms. But let whoſoever be the Contriver, it ought principally to be conſidered that ſuch Parts are to hold the Powder, Stores and Proviſions, to keep them entire one from another; with ſuch a due Regard that the leaſt Miſcarriage in the Powder may, and has made a Total Loſs.

I ſhall therefore Divide the Half of the whole Money into equal Halves, which will be 34 *l.* 11 *s.* 3 *d.* ¾. and allow each of thoſe Appartments an equal Share, only taking the Charge of Making the Stage out of it, and it will be 22 *l.* 11 *s.* 3 *d.* ¾. for making all the Store-Rooms forward, and the ſame Sum for making them Abaſt.

Store-Rooms.

In the next Place I come to the Second Deck.

Second Deck

Which is to get in the Beams, firſt Scarfing and Trimming them, to Knee them, to put in the long Carlings, and all other Carlings and Ledges, to lay the Flat of the Deck, with Plank or *Pruſſia* Deal, of three Inch and a Half thick, to get in the Main Bitts, and Croſs Pieces and Spur them; to fix Partners for the Maſts and Capſtands, and Step for the Trebble Jeer-Capſtand, with Conveniencies for the Cooks and Furnaces; ſhall be ⅓, or 138 *l.* 5 *s.* 3 *d.*

The Difference in Workmanſhip between this Deck and the Lower Deck will be as they are in Proportion one to another, provided the Handineſs of performing was equal; but if not, it ought to be otherwiſe conſidered: As firſt, the Beams are as 5 to 6, but then the Trouble in getting of them in, and up into their Places (ſince the Middle Deck Beams muſt be put up before the Clamp, and the other after its reſpective Clamp) and therefore that Trouble will counterpoize the other Advantage in being of a leſſer Scantling.

The other Diſproportion that will happen in the Workmanſhip, will be that the Middle-Deck Carlings and Ledges will be Fir, and the other Deck Oak; alſo the Flat of the Deck, except it be in the Wake of the Guns. I am therefore apt to believe that the Difference between Working Fir and Oak will be according to the Difference there is in their Weight, which is as 3 to 2: For obſerving that the Difficulty of Working Timber chiefly conſiſts in the Hardneſs and Texture of it, which to nicely demonſtrate will require Tryals, as well as a much larger Conſideration.

The Knees will be in Value as they are in Bigneſs, for the Bolts ought to be in Proportion to the Bulk of the Knee.

The Number of Beams in this Deck will be 28; ſo that for Scarfing 25, and getting them in ſhall be ⅕, or 27 *l.* 13 *s.* and Calculate them thus,

Value of the Beams, Numbering them one Forward and one Aft.

Beams.

				l.	*s.*	*d*					*l.*	*s.*	*d.*
Forward	1	Aft ——	1	1	4	0	Forward	8	Aft ——	8	2	8	6
D°. ——	2	D°. ——	2	1	11	6	D°. ——	9	D°. ——	9	2	10	3
D°. ——	3	D°. ——	3	1	15	0	D°. ——	10	D°. ——	10	2	12	0
D°. ——	4	D°. ——	4	1	19	0	D°. ——	11	D°. ——	11	2	13	8
D°. ——	5	D°. ——	5	2	2	0	D°. ——	12	D°. ——	12	2	15	3
D°. ——	6	D°. ——	6	2	4	6			D°. ——	13	1	8	4½
D°. ——	7	D°. ——	7	2	6	6							
											14	8	0½
				13	2	6					13	2	6
										Total Sum	27	10	6½

Knees. The Knees in this Deck will be 112, and will be in Proportion to the other, as 7 to 8, or 4 *s.* 10 *d.* each, × 112 by 4 *s.* 10 *d.* and it's 27 *l.* 1 *s.* 4 *d.* - 11 *s.* 8 *d.* leſs than the Sum allowed.

Next is to get in the long Carlings, and all other Carlings and Ledges, which Parts will be to the Other Decks as 5 is to 6; however there will be 29 Rooms, which is three more than there is in the other Deck, and ſo I ſhall Calculate them.

The 3 Beams left out may be placed to that Part which has more Money allowed than the Work comes to —— *l.* *s.* *d.*
4 . 3 7½.

Carlings and Ledges. *Value of the Carlings and Ledges of the Middle Deck, taking two Rooms of each, one Afore and one Aft, and proceed to the Midſhips.*

	l.	*s.*	*d.*		*l.*	*s.*	*d.*
For two Rooms.	0	15	0	For two Rooms.	1	9	8
D°.	0	19	3	D°.	1	11	1
D°.	1	1	7	D°.	1	12	5
D°.	1	3	0	D°.	1	13	8
D°.	1	4	9	D°.	1	14	10½
D°.	1	6	6	D°.	1	16	0
D°.	1	8	2	D°.	1	17	1
	7	18	3		11	14	9½
	12	13	4	For the odd Room	0	18	6½
Total	20	11	6		12	13	4
	27	1	4				
	06	10	8				

It appears by this Calculation that there will be 6 *l.* 10 *s.* 8 *d.* remaining for other Work; I ſhall therefore take in the Partners of the Maſts, and Capſtands with this Part, and making Conveniency for the Cooks. The Partners in this Deck will be in Proportion to the other Deck, in Value Working as they are in Scantlings: So that the remaining Part of the Money

Partners of Maſts.
Conveniency for the Cooks.

Money will be for making Conveniences for Dreſſing the Proviſions, but not the Brick-work.

But by the Way I ſhall take Notice that in ſome Ships there is no Carlings nor Ledges Abaſt in the Wake of the Tiller of the Rudder, but then the Beams lye thicker, and will be more of them, that the Workmanſhip will be Equivalent.

Flat of the Deck.

The laſt Part is the Flat of the Deck and Water Ways; which, if this Deck was to be wholly laid with Deal, and of equal Thickneſs, and to be Ttenel'd, then the Proportion would be as 2 to 3; but it will be near $\frac{1}{3}$ of Oak, and in Thickneſs as 7 to 9. I ſhall therefore allow it as 3 to 4, conſidering the Trouble of getting in the Material, will be more in this Deck than in the other. It will be then near 2 *d. per* Foot, and ſo I ſhall Calculate it, the Superficies being 4840 Foot, which is 40 *l.* 6 *s.* 8 *d.* from 54 *l.* 2 *s.* 8 *d.* remains 13 *l.* 16 *s.* 0 *d.* I ſhall therefore to this Part put in the Fixing the Cable Bit-Pins and Croſs Pieces, with the Spirs; and them, from their extream Weight and Bigneſs, will be very troubleſome to get Aboard and into their Places; they ought alſo to be very well fixed, and will be worth, well perform'd, 10 Pounds.

Cable Bits. Croſs Pieces. and Spirs.

Upper-Deck.

I come next to the Upper Deck. To Scarfe theſe Beams, ſince at this Time Scarfing is become very Faſhionable: and altho' it's Dearer both in Labour and Materials; yet in Conſideration that it ſaves longer Timber, for Uſes that cannot ſo well be performed without, it may be reckon'd a Piece of good Husbandry.

Then to get theſe Beams in, to double Knee them, to get in all the Carlings and Ledges, to lay the Flat of the Deck with *Pruſſia* Deal of two Inches and a Half thick, to fix all the Standers on the Upper and Middle Deck, to perfect the Well, and fix the Pumps and Ciſterns, with the Partners for the Maſts and Capſtand, the Money allowed will be one Fifth of the Whole, or 138 *l.* 5 *s.* 3 *d.*

This Deck will be, in direct Proportion to the other, as the Scantlings are; and therefore I ſhall make the Subdiviſions accordingly as they are made in the Middle Deck.

The Beams will be in Proportion one to another, as 16½ is to 13, and ſo I ſhall Calculate them, obſerving that there will be 27 Beams in this Deck.

Beams.

Value of the Beams, Numbering of them one Forward and one Aft.

				l.	*s.*	*d.*					*l.*	*s.*	*d.*
Forward	1	Aft	1	1	0	3	Forward	8	Aft	8	2	0	9
D°.	2	D°.	2	1	6	0	D°.	9	D°.	9	2	2	8
D°.	3	D°.	3	1	10	0	D°.	10	D°.	10	2	4	7
D°.	4	D°.	4	1	12	3	D°.	11	D°.	11	2	6	6
D°.	5	D°.	5	1	14	6	D°.	12	D°.	12	2	8	5
D°.	6	D°.	6	1	16	8	D°.	13	D°.	13	2	10	4
D°.	7	D°.	7	1	18	9	D°.	ϴ.	D°.	ϴ.	1	6	1
				10	18	5					14	19	4
				14	19	4							
				25	17	9							

25 *l.* 17 *s.* 9 *d.* Taken from 27 *l.* 1 *s.* 4 *d*, Remains 1 *l.* 3 *s.* 7 *d.* Shewing that there is ſo much more by Particulars than is allowed in the General for compleating the Beams.

The Knees will be in Proportion as the Beams, as 13½ is to 16, there being 108 Knees, at 3 *s.* 9 *d.* each, which will be 20 *l.* 5 *s.* Subſtracted from 27 *l.* 1 *s.* 4 *d.* remains 06 *l.* 16 *s.* 4 *d.* I ſhall therefore take into this Part all the

Standers on the Middle Deck.

the Standers on the Middle Deck, which will be 14 at 5 *s.* 3 *d.* each is 3 *l.* 13 *s.* 6 *d.* and then there will be 3 *l.* 2 *s.* 10 *d.* more by Particulars than in the General.

Next is the Carlings and Ledges, which will be in direct Proportion to their Scantling, and that is as 4 to 5, and there will be 28 Rooms.

Carlings and Ledges.

Value of the Carlings and Ledges of the Middle Deck taking the Rooms Succeſſively, as aforementioned.

	l.	*s.*	*d.*		*l.*	*s.*	*d.*
For Two Rooms.	0	12	0	For Two Rooms.	1	3	9
Dº.	0	15	6	Dº.	1	5	0
Dº.	0	17	4	Dº.	1	6	0
Dº.	0	18	6	Dº.	1	7	0
Dº.	0	19	10	Dº.	1	7	11
Dº.	1	3	3	Dº.	1	8	10
Dº.	1	2	6	Dº.	1	9	9
	6	8	11		9	8	3
	9	8	3				
	15	17	2				

Partners.

Standers on the Upper Deck.

I ſhall take in the Partners of the Maſts with this Part, and of the Treble Jeer Capſtand, alſo 14 Standards at 4 *s.* 2 *d.* each, is 2 *l.* 18 *s.* 4 *d.* the Partners of the Fore-Maſt, Mizen-Maſt, Treble Jeer Capſtand, and ſhutting up the Work in the Wake of the Main Maſt, will be worth 40 *s.* allowing that there may be Half the Work in each of theſe Partners as there is in the Lower Deck Partners, which two Sums being put to 15 *l.* 17 *s.* 2 *d.* is 20 *l.* 15 *s.* 6 *d.* which taking from 27 *l.* 1 *s.* 4 *d.* Remains 6 *l.* 5 *s.* 10 *d.* Overplus.

Flat of the Deck.

The Flat of the Deck will be in the ſame Proportion as the other Work, which is as 4 to 5, conſidering the Trouble of Pricking a two Inch Deal will be equal to the Pricking a four Inch Plank, and ſometimes the Confining of him to his Place whilſt he is pricked, will be alſo equal; the Labour will be alſo more in bringing the Material to its Place, but then this Deck will be only Nail'd, and the other Trenel'd.

From all which I ſhall make an Allowance of one Penny half Penny *per* Foot, there being in this Deck 4197 Foot, amounting to 26 *l.* 4 *s.* 2 *d.* ½, which taking from 54 *l.* 2 *s.* 8 *d.* remains 27 *l.* 17 *s.* 5 *d.* ½. There is only the Fixing of the Pumps in every particular, and building of the Well to lick up the Sum of 27 *l.* 17 *s.* 0 *d.* ½, which ſaid Part will be worth, well and nicely perform'd, 9 *l.* ſo that there will be ſtill 18 *l.* 17 *s.* 5 *d.* ½ remaining, of which I ſhall give ſome Reaſons hereafter, that there ought to be ſomething Overplus in every Particular, and proceed to the Quarter-Deck, *&c.*

Pumps.

Quarter Deck, &c.

To Trim and get in all the Beams of the Quarter-Deck, Forecaſtle Deck, and Poop Deck, to Knee them, to put in what Carlings and Ledges is requiſite, to put out all the Scuppers in the Ship, to make a Manger and Bucklers and Bars, to Fix the Partners of the Bowſprit; all Shot-Lockers upon the Decks; all Breſt-Hooks in the Ship and Steps for the Maſts, Tranſum Knees of the Main Tranſums, and Helm Port Tranſum, and Middle Deck Tranſum, with two Crutches, and all the Pillars above the Hold.

For the Beams of the Quarter-Deck, Forecaſtle and Poop, the Number will be always Various, according to the Fancy of the Builder, but I ſhall allow them to be 55 one with another; and ſome of theſe Beams will be Double Knee'd, and ſome Single, and ſome none at all: I ſhall therefore allow them to be all Single to the Number of 110 Knees.

Then to Trim theſe 55 Beams, and put them in their Places, one Deck with another. *Breadth 48.*

	l.	*s.*	*d.*	*l.*	*s.*	*d.*	
= the Breadth Extream of the Ship by 3 — 5 for the whole Sum	—	—		13	14	3	
= the Depth in Hold by 3 — 9 for each Beam	0	5	0				*Depth 19 ·7* *Beams,*
Obſerving they ſhall be in Value one to another, as the Scantling is.							
For all the Knees = the Breadth by 2-9	—	—		16	10	0	*Knees.*
Or = the Depth by 6-55, for each	0	3	0				
For the Flat of all thoſe Decks = Breadth by $2\frac{25}{120}$.	or,			21	10	0	*Flat.*
Or 5 Farthings *per* Foot on the Superficies.							
Carlings and Ledges very few.							
For all the Scuppers in the Ship one with another, = the Breadth by 6	—			8	0	0	*Scuppers.*
There being 80 = the Depth by 9·8 for each	0	2	0				
and they ſhall be in Proportion one to another, according to the Length and Diameter.				59	14	3	
For the Breaſt-hooks one with another, = the Breadth by 3-0.	—			16	0	0	*Breaſt-hooks.*
Or the Depth by 9-7 for each	2	0	9				
And to be in Value as the Scantling is.							
Tranſum Knees, = the Breadth by 2-74	—			17	10	0	*Tranſum Knees.*
Or × the Depth by 1-3 for each	1	5	0				
Crutches, = the Depth by 7-9	—			2	10	0	*Crutches.*
Or × the Depth by 1-3 for each	1	5	0				
Steps, = the Depth by 4-9 for all	—			4	0	0	
Or = the Depth by 9-7 for the Fore Step	2	0	9	0	0	0	*Steps of Maſts.*
And by 1 for the Main and Mizen Step, which is near equal in Value.	0	19	$7\frac{1}{2}$				
For Manger, Bucklers and Partners, of the Bowſprit, = the Breadth by 16-0	—	—		3	0	0	*Manger-Bucklers.*
For all the Shot-Lockers, or Garlands, on the Decks, = the Breadth by 16	—	—		3	0	0	*Shot-Lockers*
For all the Pillars of every Deck, = the Breadth by 19·0	—	—		2	5	0	*Pillars.*
Or the Depth by 2-2 for the Value of each, one with another, and to be in Value to each other, as they are in Scantling.	0	0	9				
				48	15	0	
				59	4	3	
				107	19	3	

The whole Sum allowed for theſe Particulars, is 138 *l.* 5 *s.* 3 *d.* Then take 107 *l.* 19 *s.* 3 *d.* out of it, and there Remains 30 *l.* 6 *s.* 0 *d.* which is Overplus.

I proceed now to the Deck of a Two Deck Ship; which I ſhall Divide into four Particulars. and = the whole Sum for this Uſe into four Parts. *Two Deck Ship.*

Then 379 *l.* 6 *s.* 8 *d.* = by 4, is 94 *l.* 16 *s.* 8 *d.* for each Part; which Parts are firſt, To Scarſe and Trim the Gun-Deck, or Lower Gun-Deck Beams, and get them in; to Knee them, to lay Carlings and Ledges, and the Flat of the Deck with Plank of 3 Inches and $\frac{1}{2}$ thick, with the Water-Ways, and making the Hatches, which Sum allowed is 94 *l.* 16 *s.* 8 *d.*

I ſhall again Subdivide this Part into 5, or 18 *l.* 19 *s.* 4 *d.* Firſt to Scarſe and Trim the Beams, and get them into their Places $\frac{1}{5}$, or 18 *l.* 19 *s.* 4 *d.*

To double Knee them, except in the Wake of the thick Clamp Abaſt $\frac{1}{5}$, or 18 *l.* 19 *s.* 4 *d.*

To put in the Carlings and Ledges, $\frac{1}{5}$, or 18 *l.* 19 *s.* 4 *d.* To lay the Flat of the Deck, Water Ways and Hatches $\frac{2}{5}$, or 37 *l.* 18 *s.* 8 *d.*

The Two Deck Ship of this Size, the Scantling of her Lower-Deck Beams will be to the Scantling of the preceeding Three Deck Ship as 8 to 9, or 7 to 8, and ſo I ſhall calculate them, which will give for the firſt two Beams 1 *l.* 2 *s.* 0 *d.* there will be 24 Beams in ſuch a Ship's Lower-Deck. Then I ſhall take the ſame Method of taking two Beams together, one Afore and one Aft.

Beams.

Value of the Beams, Numbering of them one Aft and one Forward.

Forward	Aft	*l.*	*s.*	*d.*	Forward	Aft	*l.*	*s.*	*d.*
1	1	1	2	0	6	6	1	18	2
2	2	1	8	0	7	7	1	19	9
3	3	1	12	0	8	8	2	1	4
4	4	1	14	0	9	9	2	3	0
5	5	1	16	6	10	10	2	4	7
		7	12	6			10	6	10
		10	6	10					
		17	19	4					

17 *l.* 19 *s.* 4 *d.* from 18 *l.* 19 *s.* 4 *d.* remains 1 *l.* 0 *s.* 0 *d.* and this is for 20 Beams; ſo that there remains the Charge of 4 ⊖ Beams, to be placed to ſome other Work, which is 5 *l.* 13 *s.* 0 *d.*

Knees.

Then the Scantling of the Knees is as 6 to 7, that the Value of each will be 3 *s.* 9 *d.* for there will be 90 Knees, allowing 21 Beams double, and 3 Single, the Sum is 21 *l* 0 *s.* 6 *d.* which I ſhall Subſtract from 17 *l.* 19 *s.* 4 *d.* the Charge of the Beams by Particulars, and there remains 1 *l.* 1 *s.* 10 *d.* for to go to other Parts.

Next I come to the Carlings and Ledges, whoſe Scantlings is to the Three Deck Ship, as 9 is to 11, or 14 *s.* 9 *d*, for the firſt Room, and ſo on.

Carlings and Ledges.

Value of the Carlings and Ledges, as afore-mentioned, 25 Rooms.

					l.	*s.*	*d.*						*l.*	*s.*	*d.*
For Two Rooms.					0	14	9	For Two Rooms					1	9	6
	6	13	4	D°	0	19	2		9	15	7	D°	1	11	0
The odd Room.	0	18	0	D°	1	0	2					D°	1	12	3
	9	15	6	D°	1	4	6					D°	1	13	4
				D°	1	6	6					D°	1	14	4
Total	17	6	11	D°	1	8	3					D°	1	15	2

The Sum for the Carlings and Ledges is 17 *l.* 6 *s.* 11 *d.* from 18 *l.* 19 *s.* 4 *d.* Remains 1 *l.* 12 *s.* 5 *d.* And ſince they are in Proportion as 9 to 11 the whole Rooms, they will be ſo in every Particular; ſo that there will be for each Carling 14 *d.* 3 *q.* and for each Ledge 4 *d.* 3 *q.* more.

Flat.

I come now to the Flat for Planking, and this Part is variouſly performed, at ſometimes with four Inch Plank, and at other times with three Inch Plank Trenel'd; from which I preſume that three Inch and a Half Plank will be more ſuitable than either of the other Sizes, which I ſhall allow at 2 *d. per* Foot, ſince the Drift of Holes in the Carlings and Ledges will be as 9 to 11, there will be 3750 Foot on the Superficies, which at 2 *d. per* Foot, is 31 *l.* 5 *s.* 0 *d.*

and the Money allowed is 37 *l.* 18 *s.* 8 *d.* Then putting to 31 *l.* 5 *s.* 0 *d.* -- 6 *l.* 13 *s.* 8 *d.* and 1 *l.* 1 *s.* 10 *d.* it is 39 *l.* 0 *s.* 6 *d.* and ſo is this Deck Finiſhed.

Orlop. In the next Place I come to the Orlop, which is to Scarph the Orlop Beams, (being Nine) to Trim them, to get them into their Places, to double Knee them, to lay the Flat of the Orlop, and make all the Store Rooms. I ſhall likewiſe add to this Part the Partners of the Lower Deck for Maſts and Capſtands, to get in the Bitt-Pins, Croſs Pieces and Spirrs, all the Croſs-Pillars and Standers on the Lower Gun-Deck; the Sum allowed will be 94 *l.* 16 *s.* 8 *d.* which I ſhall = into 4 Parts: And firſt is to Scarſe and Trim all the Beams, to Knee them.

	l.	*s.*	*d.*	
Firſt is to Trim and Scarph Nine Beams, and get them in at 1 *l.* 4 *s.* each, is ——— ——— ———	10	16	0	*Beams.*
To double Knee them at 3 *s.* 9 *d.* each, is, 18 Numb. ———	3	7	6	*Knees.*
To fix 8 Standers on the Lower Deck, at 5 *s.* each is ——— ——	2	0	0	*Standers.*
Twelve Croſs-Pillars, at 3 *s.* 5 *d.* each is ——— ——— ——	2	1	0	*Lower-Deck. Croſs-Pillars.*
The Partners of this Ship's Gun-Deck ſhall be in direct Proportion to the Three Deck Ship's Partners, as they are in Scantling, and after the ſame manner. —— ——	3	10	0	*Partners.*
Divided into four Parts, each 17 *s* 6 *d.* ———	21	14	6	

21 *l.* 14 *s.* 6 *d.* from 23 *l.* 14 *s.* 2 *d.* the Money allowed, there Remains 1 *l.* 19 *s.* 8 *d.*

Flat. The laying the Flat of the Orlop according to the Manner mentioned in the Three Deck Ship's Orlop, will be in Value according as the Flat of their Lower Gun-Deck is one to another, ſo that as 52 *l.* 7 *s.* and 8 *d.* is to 31 *l.* 5 *s.* ſo is 28 *l.* 11 *s.* 1 *d.* $\frac{3}{4}$. to 17 *l.* *Bitt-Pins, &c.* Then to get in the Bitt-Pins and Finiſh them, will be as 4 to 5, or 8 *l.* which put to 17, is 25 *l.* and 1 *l.* 5 *s.* 10 *d.* too much, which I ſhall obſerve. *Store-Rooms.* Then for making all the Store Rooms Afore and Abaft, will be 47 *l.* 8 *s.* 4 *d.* which Divided into two Parts, is 23 *l.* 14 *s.* 2 *d.* for each, only to Deduct the Charge of Making a ſubſtantial Stage, *Orlop Stage.* which to = the Ship's Breadth by 5, gives that Charge, or 8 *l.* Now 4 *l.* taken out of 23 *l.* 14 *s.* 2 *d.* Remains 19 *l.* 14 *s.* 2 *d.* for each Part of the Store Rooms Aft and Forward.

Upper-Deck. The Upper-Deck in this Ship will come neareſt to the Upper Deck of the Three Deck Ship, and from which I ſhall Calculate it. The Beams are as 5 to 6, and 26 of them. And = this Part into 5, is 18 *l.* 19 *s.* 4 *d.*

Value of the Beams, Numbering of them one Aft and one Forward. *Beams.*

Forward	1	Aft	1	*l.*	*s.*	*d.*	Forward	8	Aft	8	*l.*	*s.*	*d.*
D°	2	D°	2	0	16	10	D°	9	D°	9	1	13	11
D°	3	D°	3	1	1	9	D°	10	D°	10	1	15	7
D°	4	D°	4	1	5	3	D°	11	D°	11	1	17	2
D°	5	D°	5	1	7	0	D°	12	D°	12	1	18	8
D°	6	D°	6	1	8	10	D°	13	D°	13	2	0	1
D°	7	D°	7	1	10	6					2	1	5
				1	12	3					11	6	10
				9	2	5					9	2	5
											20	9	3

20 from 9 *l.* 9 *s.* 3 *d.* Deduct 18 *l.* 19 *s.* 4 *d.* Remains 1 *l.* 9 *s.* 11 *d.* Overplus.

Knees. The Knees will be to the Upper-Deck Knees of a Three Deck Ship, as 7 to 6, or 3 *s.* 2 *d.* each, and being 104 of them it will be 16 *l.* 19 *s.* 4 *d.* from 18 *l.* 19 *s.* 4 *d.* Remains 2 *l.* 10 *s.* 4 *d.* leſs.

The

Carlings and Ledges. The Carlings and Ledges in this Ship will be to the Carlings and Ledges in its reſpective Deck in the other Ship as 5 to 6, and ſo I ſhall Calculate them, being 27 Rooms.

Value of the Carlings and Ledges as afore-mentioned, 6.

		l.	s.	d.		l.	s.	d.
	For Two Rooms	0	10	0	For Two Rooms	0	19	10
5 5 8	Dº	0	12	11	7 17 6 Dº	1	0	9
7 17 6	Dº	0	14	5	Dº	1	1	8
	Dº	0	15	4	Dº	1	2	7
13 3 2	Dº	0	16	6	Dº	1	3	5
12 6	Dº	0	17	8	Dº	1	4	3
	Dº	0	18	10	Dº 1 Room 12 *s.* 6 *d.*	1	5	0
13 15 8								

		l.	s.	d.
	The Sum of 13 *l.* 15 *s.* 8 *d.* from 18 *l.* 19 *s.* 4 *d.* Remains --	5	3	8
Partners.	I ſhall take into this Part the Partners of the Fore Maſt, Mizen-Maſt, and ſhutting in the Work about the Main-Maſt, which will be in Proportion to the Upper-Deck of the Three Deck Ship, as 8 to 10, only taking the Step of the Treble Jeer out. × the Depth in Hold, which is 16 Ft. 8 In. by 1-4.	1	3	6
Pillars.	Then all the Pillars of the Lower-Deck, = the Depth by 5-1 for the whole Charge.	3	3	0
	And by 7-3 for each Pillar, which is 2 *s.* 7 *d.* ½, being 24 of them.			
Step of the Main Capſtand.	The Step of the Main-Capſtand, = the Breadth, which is 40, by 7-5, it's	0	5	3
	4 *l.* 11 *s.* 9 *d.* from 5 *l.* 8 *s.* 8 *d.* Remains 0 *l.* 16 *s.* 11 *d.* —	4	11	9

Flat. I now proceed to the Flat of this Deck, which will be in direct Proportion to the Flat of the Upper-Deck in a Three Deck Ship, as their Areas of the Superficies is, for they are both two Inch and a Half Deal.

Standers. Upper Deck. Pumps. The Area is 3500 Foot, at 1 *d.* ½ *per* Foot, which amounts to 21 *l.* 17 *s.* 2 *d.* Then I take into this Part the Standers, which will be 10, at 3 *s.* 6 *d.* each, is 1 *l.* 15 *s.* Then the Pumps will be in Proportion to the other Ships as 9 to 5, which is 5 *l.* for Fixing a Well and two Pumps; which Sum of 21 *l.* 17 *s.* 2 *d.* and 1 *l.* 5 *s.* and 5 *l.* put together, is 28 *l.* 12 *s.* 2 *d.* which taken out of 37 *l.* 18 *s.* 8 *d.* Remains 9 *l.* 6 *s.* 6 *d.* Overplus.

Next I come to the Quarter-Deck, Forecaſtle and Poop, which is alſo to be ¼ of the Whole, or 94 *l.* 16 *s.* 8 *d.* and here I ſhall Divide every Part by particular Multiplications and Diviſions.

Quarter-Deck, &c. The Breadth of the Ship Extream is 40 Foot, and the Depth in the Hold 16 Foot, 8 Inches.

		l.	s.	d.
Beams.	For the Beams, being 40, = the Breadth by 4 or by 10, for each Beam — 4 *s.*	10	0	0
Knees.	For 100 Knees divide the Breadth by 4, or by Knee 20, for each — 2 *s.*	10	0	0
Flat.	For the Flat of the Deck = the Breadth by 3-4, or 5 Farthings *per* Foot, Superficies is 2189 Foot.	11	7	8
Scuppers.	For 55 Scuppers, = the Depth by 4 or × the Depth by $1\frac{9}{10}$, for each 1 *s.* 6 *d.*	4	2	
Breaſt-hooks.	For the Breaſt-hooks, being 6, = the Breadth by 3-9 or × the Depth by $2\frac{5}{10}$, for each 1 *l.* 5 *s.*	10	5	0

For

	l.	s.	d.	
For 12 Tranſum Knees, = the Breadth by $3\frac{22}{100}$. or the Breadth by 2, for each 20 *s.*	12	8	0	*Tranſum. Knees.*
For 2 Crutches, = the Breadth by 20 or = the Breadth by 2, for each 20 *s.*	2	0	0	*Crutches.*
For the Steps of the Maſts, = the Depth by 4 - 8	3	10	0	*Steps.*
For the Fore-Step, × the Depth by $2\frac{11}{100}$. 35 *s.* and for each of the other 2 = the Breadth by 2 - 3, 17 *s.* 6 *d.*				
For Manger-Bucklers, and Partners of the Bowſprit × the Depth by $3\frac{1}{100}$	2	10	0	*Manger and Bucklers.*
For Shot-Lockers on all the Decks, D°	2	10	0	*Shot Lockers*
For 50 Pillars, = the Depth by 2 - 46 for the whole or the Depth by $2\frac{22}{100}$, for each 7 *d.* $\frac{1}{2}$.	2	1	0	*Pillars.*
	70	13	8	
	94	16	8	
Remains —	24	3	0	

The whole Sum allowed for theſe Particulars being 94 *l* 16 *s.* 8 *d.* and the Sum, according to the real Worth, but 70 *l.* 13 *s.* 8 *d.* there Remains 24 *l.* 3 *s.* 8 *d.* Overplus.

I proceed now to the Decks of a Sixth Rate, or a One Deck Ship; and ſince ſhe has but one entire Deck, beſides Quarter-Deck, Forecaſtle-Deck, and ſome Platform, I ſhall make but two Diviſions of it, and the Sum allowed is 71 *l.* 15 *s.* which halved is 35 *l.* 17 *s.* 6 *d.* Breadth extream 24 Foot, Depth 10 Ft. 10 In. *One Deck Ship.* *Main-Decks.*

	l.	s.	d.	
Firſt 16 Beams, = the Breadth by 6 - 8, for all or the Depth by 3 - 6, for each 4 *s.*	3	12	0	*Beams.*
For 64 Knees = the Breadth by 5 - 10, for all and × the Depth by 11-8 for each, or 1 *s.* 6 *d.*	4	16	0	*Knees.*
For the Flat of the Deck, = the Breadth by 3 - 3 or 5 Farthings *per* Foot, being 1400 Foot	7	5	10	*Flat.*
To Fix Well and Pumps, × the Depth by 3 - 5 $\frac{25}{100}$	1	15	0	*Pumps.*
To fix one Breaſt-hook, = the Breadth by 2	0	12	0	*Breaſt-hooks.*
For Carlings and Ledges, = the Breadth by 7 - 4	3	4	7	*Carlings and Ledges.*
For 5 Pair of Partners × the Depth by 2 - 9	1	10	0	*Partners.*
Other Jobs of Finiſhing, × D°	1	10	0	
	24	5	5	

24 *l.* 5 *s.* 5 *d.* taken from 35 *l.* 17 *s.* 6 *d.* Remains 11 *l.* 12 *s.* 1 *d.*

Next is to get in the Beams of the Quarter-Deck, and Forecaſtle, and to Knee them; to put in what Carlings and Ledges are needful, to lay the Flat, to get in the Bitts and Spirr them, to build all the Store-Rooms and Platforms, with all Conveniences under the Deck, which is done by the Ship Carpenters, to fix the Breaſt-hooks, Steps of Maſts and Capſtands; alſo the Tranſum Knees, to put out all the Scuppers, to build Shot-Lockers, and ſet up all the Pillars: The Sum allowed is 35 *l.* 17 *s.* 6 *d.*

	l.	s.	d.	*Quarter Deck, &c.*
For 16 Beams, = the Breadth by 7 - 9 or 3 *s.* 9 *d.* each Beam.	3	0	0	*Beams.*
For 32 Knees, = the Breadth by 7 - 9 or 1 *s.* 10 *d.* $\frac{1}{2}$ each	3	0	0	*Knees.*
Flat of the Deck 630 Foot, at 1 *d.* *per* Foot	2	12	6	*Flat.*
Bitts and Spirrs, × the Breadth by $1\frac{23}{100}$	1	10	0	*Bitts, &c.*
For Platforms and all Store-Rooms, = the Breadth by 2 - 4	10	0	0	*Platforms.*

		l.	*s.*	*d.*
Stage.	For Making the Firſt Stage in Hold, × the Breadth by $1\frac{23}{100}$	1	10	0
Breaſt-hooks.	For three Breaſt-hooks, × the Breadth by 1 - 5	1	16	0
Tranſum Knees.	For 6 Tranſum Knees, × the Breadth by D°	1	16	0
Steps of Maſts.	Steps of Maſts { Fore Step, = the Breadth by 2	0	12	0
	Main and Mizen Step = the Breadth by 4 each	0	6	0
Step of Main Capſtand.	Step of the Main Capſtand, = the Breadth by 6	0	4	0
Shot-lockers.	All Shot-Lockers, = the Breadth by 3	0	8	0
Scuppers.	Scuppers 24, = the Breadth by 1 - 1	1	2	0
	or × the Depth by $1\frac{1}{100}$, for each 11 *d.*			
Pillars.	30 Pillars, × the Depth by $1\frac{12}{100}$	0	12	0
	or = the Depth by $2\frac{15}{100}$, for each 5 *d.*			
		28	8	8

28 *l.* 8 *s.* 8 *d.* out of 35 *l.* 17 *s.* 7 *d.* Remains 6 *l.* 8 *s.* 10 *d.*

A Veſſel with Half Decks. The next is a Veſſel having only Half Decks, of 62 Foot long on the Deck Line, and 15 Ft. 6 In. Broad. I ſhall therefore make but one ſingle Calculation, which will be to get in the Beams and Knee them, to put in Carlings and Ledges, with the Flat of the Deck; to build all Store Rooms or Cabbins which is done by the Hand of the Shipwrights; to fix three Breaſt-Hooks, four Tranſum Knees, Steps for the Maſts and Partners, to put in the Bitts, to put out all Scuppers, put up all Pillars; and the Money allowed for the ſame will be 14 *l.* 0 *s.* 9 *d.*

		l.	*s.*	*d.*
Beams.	For 15 Beams, × the Breadth by $1\frac{46}{100}$ for all	1	2	6
	or × the Breadth by $1\frac{17}{100}$, for each 18 *d.*			
Knees.	30 Knees at 10 *d.* each, × the Breadth by $1\frac{61}{100}$, for all	1	5	0
Store-Rooms.	For all Store-Rooms, or Cabbins, that's done by the Hands of the Shipwrights, = the Breadth by } 2 - 6	6	0	0
Flats.	For Planking the Decks, = the Breadth by $7\frac{15}{100}$	2	2	0
	Superficies various, but at 1 *d. per* Foot			
Breaſt-hooks.	Breaſt-hooks 3, × the Breadth by 1 - 3; 6 *s.* 8 *d.* each	1	0	6
Tranſum Knees.	Tranſum Knees 4, = the Breadth by 1 - 1	0	14	0
	or 3 *s.* 6 *d.* each			
Steps of Maſts.	Steps of Maſts and Partners various, but = the Breadth by $1\frac{25}{100}$	0	10	0
Bit-Pins.	Bitts, = the Breadth by 3 - 1	0	5	0
Scuppers.	Scuppers 4, = the Breadth by 6-8 for all, or by 2-2, for each 7 *d.*	0	2	4
Pillars.	Pillars 4, = the Breadth by $1\frac{6}{100}$, for all	0	1	2
	or by 4 - 4, for each 3 *d.* ½			
		13	2	6

13 *l.* 2 *s.* 6 *d.* out of 14 *l.* 0 *s.* 9 *d.* Remains 0 *l.* 17 *s.* 3 *d.*

For a Boat. Then for a Boat that has only Thwarts, the Sum will be but ſmall, as in the aforementioned Boat, the Sum is but 7 *s.* 6 *d.* not worth the Trouble of Subdividing it, in ſuch an Abbreviate as this. I ſhall only mention that the Subdiviſions of all Boats will come very near as follows.

Firſt the Boarding $\frac{1}{8}$, for Timbering $\frac{3}{8}$; then to Fit the Keel, Stem, Tranſum and Poſt, and Raiſing them, and putting on the Dead Wood, Afore and Abaft $\frac{2}{3}$, of the laſt mentioned $\frac{3}{8}$, ſince the Floor Timbers will require no Choking, neither the Foot-hooks any Framing.

But ſince the Care requiſite to Trim the Floor Timbers and Foot Hooks, and alſo the Frame to be truly Level'd and Shor'd, I will Divide the whole Money allowed for Timbering into 7th's, and allow that Raiſing the Keel Stem and Stern, will be $\frac{4}{7}$ of the $\frac{3}{8}$, and the Floor and Foot Hooks $\frac{3}{7}$ of the $\frac{3}{8}$, or 7 *s.* 6 *d.*

Then putting in the Lower and Upper Riſings and Thwarts, and to Knee them, with Fitting the Burton Boards, will be $\frac{3}{8}$ or 7 *s.* 6 *d.*

The Benches, Stern Sheets, Fore Sheets, Back Board, Rudder, Rowlicks and Stretchers and Bolts, in the Stem and Stern $\frac{2}{3}$ of the Half Part, and ſo is the Money, obſerving that one Half goes for the Boarding.

Finiſhing.

I come now to the Finiſhing Work, which conſiſts of Head, Stern, and Galleries, which Parts conſiſt of divers others, as Firſt of the Head.

Head.

The Head firſt conſiſts of a good and ſubſtantial Knee (by moſt called a Cut-Water) with a Trail, Lace and a Lyon, or ſome other Figure, fitted on the Knee; then Cheeks or Knees, bolted to the Main Knee, and alſo to the Ship; then Rails, Timbers and Brackets, as Cuſtomary, with a Kelſon and Stander, Beams or Croſs Pieces, and then Knee'd, Tack-Pieces, Carlings and Ledges, Gratings, with Houſes of Eaſement as cuſtomary, Cat-Heads, Supporters, Linings for the Bows, and Gripe, with a Quaif on the Locks of the Lyon, and Gammoning Hole, and a Hole for the Bob-Stay, with Horſe Bolts.

Stern Galleries and Rudder.

The Stern conſiſts of Timbers, Tranſums for all the Decks above the Firſt, and Kneeing them, then to work upon thoſe Timbers, Deal of divers Thickneſs, according to the Magnitude of the Ship; to fit in Stiles, Rails, Brackets, Tafferal and Quarter-Pieces.

To range a Gallery of each Side, with Walks and Balconies, building them with Stools and Timbers, according to Cuſtom, with Rails, Stiles, and a Finiſhing Piece a Top.

To make and hang a Rudder, Tiller and Sweep, Cleets and Whip-Staff, or Wheel, with the Helm-Port Tranſum.

Capſtands.

Next is Capſtands, as Main and Main Jeer, with a Treble Jeer, if any, or a Windlace, and all Bars or Handſpikes to purchaſe withal.

Steeridge Bulkhead.

Then Steerage Bulkhead, with Gangways, Ladders for the Entring Port, and a Grating from the Quarter Deck to the Main Maſt.

Forecaſtle.

The Bulkhead of the Forecaſtle, with the Belfry and Beak Head.

Gratings.

The Grateings on the Middle Deck and Upper Deck, Quarter Deck and Forecaſtle, with a Pair of Gallows, and Conveniency for the Maintopſail ſheet Bits and Jeer Bits, and Carlings under the Grateings.

Stairs,

A Pair of Flying Stairs to go from the Middle Deck to the Bulkhead of the Gun-room, and a pair of Winding Stairs from the ſaid Part of the Middle Deck to the Lower Coach, with a Pair of Tortoiſe Stairs from that Part of the Lower Coach to the Quarter Deck.

Stairs.

Then two pair of Twiſted Stairs from the Quarter Deck to the Poop, and two Pair of the ſame from the Upper Deck to the Forecaſtle.

Stairs.

One Pair of Tortuous Stairs to go out of the Forecaſtle to the Middle Deck, and another Pair of the ſame to go from that Part in the Forecaſtle up upon the Forecaſtle, Rails and Balliſters, if any included.

Stairs.

One Pair of curious Bell Stairs, to go from the Bulkhead of the Lower Coach to the Middle Deck, with a Staircaſe to it.

Ladders.

For Ladders, according to what is requir'd.

Bulkhead of the Coach, and moſt of the Conveniencies for the Rigging.

The Bulkhead of the Upper Coach or Round-Houſe, Companion for the Whipſtaff, if any, Mainſheet Blocks in the Sides, Kivils for the Main Brace, and Mizen-ſheet and Topſail Hale-yards, with Blocks for the Topſail Hale-yards, Blocks for the Main and Fore-ſheets and Spritſail-ſheets.

Blocks for the Main and Fore Lifts, and Main and Fore-top Bowlines, and Main and Foretopſail Clue-lines and Bunt-lines, Foretopſail ſheet Bitts and Jeer Bitts, Snatch Blocks for the Cat-falls, and Ranges for the Main and Fore-ſheets and Spritſail-ſheets, Choks for the Davit, Bolts for the Main and Fore top Tackles, and Main and Fore-ſheet, and Main and Foretopſail Hale-yards; Stopper Bolts on the Lower Deck for the Cables, and on the Upper Deck, Laſhing Bolts for the Long-Boat, Laſhing-Bolts for the Cables, Bolts for the Main-clue Garnets, and for other Tackles, Bolts for Laſhing Guns, *&c.*

Channels.

Then Without-Board, Main, Fore and Mizen Channels, with a proper Number of Chain Plates, Backſtay Plates, Ring Plates; for the Runner and

Tackles;

Entring-Port Fenders, Steps, Cheſtrees. Tackles; To Spur or Knee the Channels, with a Rail on each Back of the Channel; to fit Entring Ports, if any, and Steps of the Side, with Skids or Fenders, and Cheſtry, or Conveniency to Tack the Weather Clue of the Main Sail.

Planſheers, Rails. To Plan-ſheer and Gunnel, with all Rails as cuſtomary, proper, and ornamental, with Fife Rails, and Drift Pieces, and all Finiſhing Pieces.

For Squaring, which is for a certain Number of Men to attend the Calkers, to do any ſmall Jobbs that may, and always will happen; as to drive out ſhort Trenels, and drive others in the Room, to cut Butts that's too cloſe, to nail Rents, put in Pieces, or do any thing that is required for the Good of the Calking.

For a Three Deck Ship 48 Foot broad.

Length on the Lower Gun Deck 170 Foot,
Depth in Hold 19 Ft. 7 In.

	Value.		
	l.	s.	d.
For the Head and all that Article, = the Breadth by 1-0	48	0	0
For the Stern Galleries and that Article, × the Depth by 3-5	68	10	0
For all the Capſtands, = the Breadth by 2-4	20	0	0
For the Steeridge Bulkhead and that Article, = the Breadth by 8-	6	0	0
For the Bulkhead of the Forecaſtle and that Article, = the Breadth by 8	6	0	0
For the Grateings and that Article, = the Length on the Lower Deck by 18-5	9	0	0
For three Pair of curious Winding and Tortoiſe Stairs, and Rails, and Balliſters to them if required, = the Breadth by 3	16	0	0
	173	10	0

	l.	s.	d.
For four Pair of Twiſted Stairs at the Bulkhead, = the Breadth by 12	4	0	0
For Two Pair of Tortoiſe Stairs in the Forecaſtle, = the Breadth by 12	4	0	0
For one Pair of curious Bell-Stairs at the Bulkhead of the Lower Coach, with a Stair-caſe, = the Depth by 2-0	9	13	6
For every Ladder that is required, = the Breadth by 5	0	9	7
For the Bulkhead of the Upper Coach, and that Article, = the Breadth by 4-0	12	0	0

This Part conſiſts of 11 Blocks, at 5 *s.* 6 *d.* each; the Bitts 2 *l.* or 10 *s.* each; 6 Pair of Kivels 1 *l.* 8 Ranges, 1 *l.* Snatch-Blocks 2, and 2 Choks 12 *s.* 80 Bolts, 3 *d.* each one with another.

For the Main, Fore and Mizen Channels, and that Article, = the Breadth by 2-0	24	0	0

For the Channels, = the Breadth by 3-4, 14 *l.* For Entring-Ports = by 12, 4 *l.* Cheſtries and Fenders, = the Depth by $4\frac{32}{100}$, 4 *l.* 10 *s.* and for the Steps by $1\frac{52}{100}$, × the Depth, or 30 *s.*

For all the Rails and that Article, = the Breadth 3-3	14	0	0
	68	3	1
	173	10	0
	241	13	1

Gun-

	l.	s.	d.
Gun-Ports, Ring-Bolts and Eye-Bolts 400, at 4 *d.* each	6	13	4
Half-Ports 44, at 3 *s.* each	6	12	0
Stanchions for the Quarters, Forecaſtle, and Tops, 40, 6 *d.* each	1	0	0
Rolls 9, at 3 *s.* each	1	7	0
Wedging the Maſts, 8 Partners, at 12 *s.* each	4	16	0
and three Partners on the Upper Deck, at 6 *s.* each	0	18	0
Canting about the Bowſprit	0	12	0
Bucklers and Bars 6 Pair, at 4 *s.* a Pair	1	4	0
For Square-Making for the Calkers, = the Breadth by 6	8	0	0
	34	2	1
	241	13	1
	275	15	2

The Money allowed is 345 *l.* 6 *s.* 7 *d.* Subſtract 275 *l.* 15 *s.* 2 *d.* Remains 75 *l.* 11 *s.* 2 *d.*

Calculations for a Ship with Two Decks.

Length on the Lower Gun-Deck — 150 Ft.
Breadth Extream — 40
Depth in Hold — 16 Ft. 8 In.

	Value l.	s.	d.
For the Head and all that Article, = the Breadth by 1-2	33	7	0
For the Stern Galleries and all that Article, × the Depth by 2-8	47	0	0
For all the Capſtands, = the Breadth by 3-6	11	16	0
For the Bulkhead of the Steeridge and all that Article, = the Breadth by 9-9	4	2	0
For the Bulkhead of the Forecaſtle and that Article, = the Breadth by 9-9	4	2	0
For the Grateings and all that Article, = the Length on the Gun-Deck by 37-3	4	0	0
For nine Ladders, = the Breadth by 8-9	4	10	0
For two ſmall Ladders in the Forecaſtle	0	5	0
For the Bulkhead of the Upper Coach and that Article, = the Breadth by $4\frac{17}{12}$.	8	5	0
	117	7	0

11 Blocks at 3 *s.* 9 *d.* each. Bitts 1 *l.* 7 *s.* 6 *d.* or 6 *s.* 10 *d.* ½ each. Kivels 6, — 13 *s.* 9 *d.* Ranges 8, — 13 *s.* 9 *d.* 2 Blocks and 2 Choks 12 *s.* Bolts 80, at 2 *d.* ¼ each.

	Value. l.	s.	d.
For the Main, Fore, and Mizen Channel, and that Article, = the Breadth by $2\frac{38}{100}$.	16	18	0
For the Channels, = the Depth by $1\frac{72}{100}$, 9 *l.* 16 *s.* For the Entring-Port, if any, = the Depth by 5—9, 2 *l.* 17 *s.* And for the Cheſtrees by 5—3, 3 *l.* 4 *s.* and for the Steps, × the Depth by $1\frac{24}{100}$, 20 *s.* 9 *d.*			
For all the Rails and Planſheers and that Article, = the Breadth by 4—2	9	11	0
For the Gun-Ports, Ring-Bolts, and Eye-Bolts 280, at 3 *d.* each	3	10	0
Half-Ports 20, at 2 *s.* 1 *d.* each	2	1	8

	l.	s.	d.
Stanchions for the Quarters, Forecaſtle, and Tops, 36, at 4 *d.* 1 *f.* each	0	12	9
Rolls 9, at 2 *s.* 1 *d.* each	0	18	9
Wedging the Maſts, 5 Partners, at 8 *s.* 3 *d.*	2	1	3
Three Pair at 4 *s.* 1 *d.* each	0	12	3
Shutting the Work in about the Bowſprit	0	8	3
For ſix Pair of Bucklers and Bars, at 3 *s.* each Pair	0	18	0
For Square-making for the Calkers, = the Breadth by 6—7	6	0	0
	43	11	11
	117	7	0
	160	18	11

The Money allowed is 189 *l.* 13 *s.* 4 *d.* Subſtract 160 *l.* 18 *s.* 11 *d.* Remains 28 *l.* 14 *s.* 5 *d.*

Calculations for a Ship having one Deck:

Length on that Deck — 96 Ft.
Breadth Extream — 24
Depth in Hold — 10 Ft. 10 In.

	Value. l.	s.	d.
For the Head and all that Article, = the Breadth by 4—0	6	0	0
For the Stern Gallerys, or Badge, and that Article, = the Depth by 1—25	8	10	0
For Windlace and Capſtand, = the Breadth by 7—2	3	6	0
For the Bulkhead of the Steeridge and that Article, = the Breadth by 24—0	1	0	0
For the Bulkhead of the Forecaſtle, Beakhead and that Article, = the Breadth by 24—0	1	0	0
For the Grateings and that Article, = the Length on the Deck by 3—2 in Shillings 30 *s.*	1	10	0
For two Ladders = the Breadth by 2—4	0	10	0
For the Article of the Upper Coach, × the Depth by 2—5	1	7	0
viz. 7 Blocks, 1 *s.* each, 7 *s.* Bitts 8 *s.* or 2 *s.* each. Kivels 4, 9*d.* each, or 3 *s.* Ranges 4, 6 *d.* each, or 2 *s.* Two Snatch-Blocks, and two Choks for the Davit, 2 *s.* Bolts 60 at 1 *d.* each 5 *s.*			
For the Channels and that Article, = the Breadth by 6	4	0	0
	27	3	0

For the Channels and Backſtay Plates, and Ring-Plates, = the Breadth by 7—3, 3 *l.* 6 *s.* For the Cheſtrees, and Fenders and Steps, = the Breadth by $1\frac{72}{100}$, 14 *s.*

	Value l.	s.	d.
For all the Rails, Planiheers, and that Article, = the Breadth by 10—4.	2	6	0
Bolts for the Gun-Ports 96, 1 *d.* each	0	8	0
Half-Ports, 20, 1 *s.* each	1	0	0
Stanchions 20, 3 *d.* each	0	5	0
Wedging Maſts, 3 Partners and two Coats	0	6	0
Bowſprit Securing	0	1	2
Hawſe-Pluggs, 3	0	3	0
For Square-making for the Calkers, × the Breadth by $1\frac{18}{10}$.	1	8	0
	5	17	2
	27	3	0
	33	0	2

The Money allowed is 35*l.* 17*s.* 6*d.* Subſtract 23*l.* 0*s.* 2*d.* Remains 2*l.* 17*s.* 4*d.*

Calculations

Calculations for a Ship or Veſſel having only Half-Decks.

Length at theſe Half-Decks — — 62 Foot.
Breadth Extream — — 15 Ft. 6 In.

	Value		
	l.	*s.*	*d.*
For the Head, if any, = the Breadth by 9-0	1	14	0
For the Stern and that Article, = the Breadth by 7-0	2	4	6
For Windlace and Bitts, = the Breadth by 1$\frac{15}{10}$. In *s.*	0	13	6
One Ladder, = the Breadth by 3, for *s.*	0	5	2
For Channels, = the Breadth by 3, for *s.*	0	5	2
For Planſheers and Rails, *&c.* = the Breadth by 1-6 *s.*	5	9	6
For Hatches and Scuttles, = the Breadth by 2-6 *s.*	0	6	0
For Square-making for the Calkers, = the Breadth by 2-6	0	6	0
	6	3	10

Total allowed is 7 *l.* 0 *s.* 4 *d.* $\frac{1}{2}$ Subſtract 6 *l.* 3 *s.* 10 *d.* Remains 0 *l.* 16 *s.* 6 *d.* $\frac{1}{2}$

As to the Planking of either Ship or Boat, I am really of Opinion, that the Price allowed, according to this Calculation, is not one Penny too much; Conſidering the Care which ought to be taken in that Part, above all others.

Which is in nicely Dubing the Timbers, and curiouſly Joyning the Plank to them, both Within-board and Without board, with well and firmly faſtening of them together.

The Timbering Part will alſo be worth full as much in all Ships; and indeed in the ſmalleſt Size, ſuch Prices will be ſomething too little to perform the Work well.

As to the Decks, which is chiefly Contrivance for Accommodation, and is always various, according to the Fancy of the chief Owner or Manager; and therefore it will be very rare to ſee any Ship built without Alterations in that Part above all others.

From whence it will be very reaſonable, that the Sum allowed in the General ſhould be conſiderably more, than what may reaſonably be thought ſufficient to be allowed in Particulars.

Neither can it be thought very unreaſonable to conſider it in all other Parts, ſince Timber is ſo very deceitful, and often proves rotten, which will be a Hinderance, and if not allowed in each Particular, it will be ſure to fall heavy at laſt on the Charge of Building the whole Fabrick.

The Finiſhing Work is alſo variouſly performed, and often altered, according to Fancy.

Beſides, there will be the Launching of the Fabrick to be conſidered in the Charge of Finiſhing, which will be very Chargeable in large Ships; and therefore altho' this be the Firſt Draught, it will not be found much out of the Way.

I ſhall only mention at preſent one Caution which ought to be obſerved in Lumping of Ship-work, which is, That the Fuller or Blunter any Ship is the Larger the Price ought to be for Building of her, both in Materials and Workmanſhip, of which I ſhall lay down one ſmall Figure to explain, and as to the Conſideration of the Charge in Rebuilding or Pulling out one Piece and putting in another, I ſhall refer till another Opportunity.

Sir *William Petty* has mention'd ſomething of that Nature, concerning Springing reſilient Bodies, and ſays in trying by Weights he finds, if a certain Weight is ſufficient to bend any Body, then four times that Weight ſhall bend that Body but twice as far.

As ſet the Caſe that every Curve in the Figure A, repreſented the Shape of ſo many Ships Bows or Buttocks, and that the Plank that covered thoſe Parts was at firſt naturally Straight as *I*, *l*, *k*; and to bend to the ſeveral Curves.

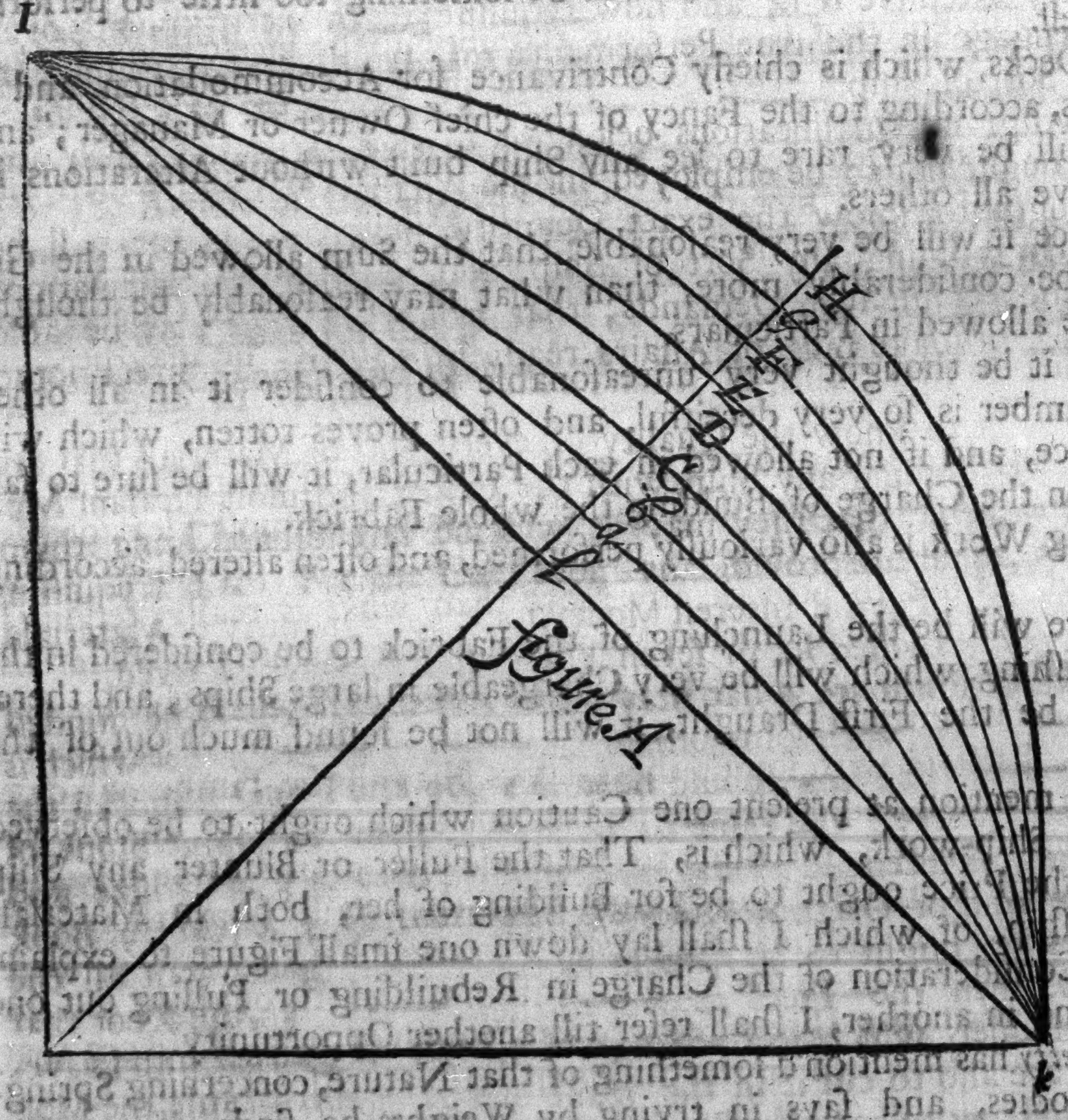
Then if the Plank was bent to *a*, with one Pound Weight, it would require four Pound to bend it to *b*, and 9 Pound to bend it to *c*, and 16 Pound to bend it to *D*, and 25 Pound to bend it to *E*, and 36 Pound to bend it to *F*, and 49 Pound to bend it to *G*, and 64 Pound to bend it to *H*; and ſo on according to the Roots of ſuch Doubling.

However I am not of Opinion, for Experience has learned me better, that if ſuch Planks were to be bent by Fire and Water, as is uſual on Ship-work, that it would require Time proportionally to the Weights: No, it would certainly bend faſter at laſt than at firſt, provided there was good Management uſed by Fire and Water; however it will be always found various, according to the good or ill Diſpoſition of the Timber, and alſo the Management thereof.

Beſides till the Plank is thorough Hot, it will be found to bend according to the aforeſaid Rules of Weights; but after it is Hot it will bend much faſter, provided it be kept well tended.

From which Obſervation, and others that may intervene, I ſhall venture to ſay, that there will be ſeven Hours Difference in bending the Innermoſt and the Outermoſt Plank by Fire and Water.

Then ſet the Caſe that there will be 60 ſuch Planks on a Ship, it will be 40 Days Difference, or 6 Pounds.



And

OECONOMY

IN

Ship-Building Compleat.

OE*conomus*, or Houſe-keeper, one that is entruſted to manage for another, ought to be faithful as a Steward, or Diſpoſer of Money. By which Similitude I ſhall more fully and particularly conſider that moſt neceſſary Order in Marine Architecture, and ſhew how very extenſive it is, and how requiſite to be nicely conn'd over by thoſe that engage in the true Performance of Building, Rebuilding, or Equipping any Sort of Ship.

There are two grand Qualifications belonging to this Part, and which any Man wanting, ought not to be employed in the Affair.

Firſt, He ought to know the exact Quantity of Material that will be wanting towards Building any Sort of Ship, and to have nice Calculations ready at all Times to ſuit ſuch Demands; that from thence he may be able to proceed, either to make Bills of Affairs ready himſelf, or to direct ſome others ſo to do.

Secondly, He ought to know the Quality of every Sort of Materials that are to be applied in Compoſing any Ship, with the Eaſieſt and moſt Pleaſant Method of obtaining them, that they may as well be ſure of providing them when demanded, as not to provide any more than what is really requiſite, from a Conſideration of Paying Intereſt Money for a vaſt Quantity of Materials, that may as well be provided ſix or ſeven Years after they are received.

Several Architects intimate what may be uſeful, and ought to be minded in our Practice. *Palladio*, with ſome others, ſays, That all the Timber which is uſed in one particular Building ſhould be cut out of one Forreſt, and all the Stone out of one Quarry; the Lime to be made out of the ſame Stone of which the Building is intended; imagining that they will ſympathize and joyn better, by a kind of Original Kindred. *Vitruvius* hath it (cap. 9. Book 2.) Timber, ſays he, ought to be fell'd in Autumn, and throughout all the Winter; becauſe then the Trees recover to themſelves from the Root that Strength and Soundneſs which in the Summer Seaſon is diſperſed into Leaves and Fruit: You are alſo to cut it in the Wane of the Moon, becauſe the Moiſture which is moſt apt to rot the Wood is then conſumed, from whence it ſhould be cut to the Middle of the Pith, and ſo left until it be Dry; becauſe by Drops there will paſs away that Moiſture which would cauſe Putrefaction;

from whence there would come no Worm to hurt it. Lay it from the Sun, Wind and Rain, if it be poſſible, and that is chiefly to be kept Dry, which is of ſpontaneous Growth; neither will it be, in leſs than three Years, fitting, or dry enough to uſe in Plank, Doors, or Windows, if no Artifice is uſed.

Vincent Scamozi hints to the Reader, if order was not obſerved in any Sort of Buſineſs, it will be all Chaos, as the Poets Fancy.

Maſter *Eyelyn* mentions the Opinion of *Vitruvius* concerning an accompliſh'd Architect, that he ſhould be endowed with no leſs than Twelve rare Qualifications. 1 Docil and Ingenious. 2. He muſt be Literate. 3. Skillful in Deſigning and Drawing. 4. In Geometry. 5. Opticks. 6. Arithmetick. 7. Hiſtory. 8. Philoſophy. 9. Muſick. 10. Medicine. 11. In the Law; and, 12. In Aſtrology: And ſo proceeds to give his Reaſon why the Artiſt ſhould be ſo qualified: Not that he expects one Single Man ſhould riſe to the Perfection, or be ſo accurate in every one of theſe Faculties, as a Man that has conſtantly attended the Study of one particular Science.

The *Greeks* would not be over-reached in their Contracts, but had ſuch a Cuſtom that if any Clerk undertook a Work, and ſpent more than his Calculation amounted too, he ſhould be obliged to make it good out of his own Eſtate; ſince the Art of Architecture conſiſts not barely in Words, for the Demonſtration ought to be Senſible and Ocular.

However, ſince the preceeding Qualifications no where include ſuch as ought to be known by the Marine Architect; as the Laws of Motion, and Gravitating of Bodies in Fluids, without the Knowledge of which no Man can call himſelf a compleat Shipwright. But the Matter in Hand falls ſhort of ſuch Enquiries, it being only that Qualification which will be undeniably requiſite in providing the Materials for Building and Equipping the Machine; which ought to be conſidered ſeveral Ways, as follows.

For, as I ſaid before, he ought to be a very good Judge of Building and Compoſing the Ship, and what will be abſolutely requiſite, and what may be ſpared, in caſe it cannot be obtain'd.

He ought alſo to be very well inform'd of the Product of our own Kingdom, and how to encourage the Manufacture by employing the Utenſils of our Native Soil before that of a Foreign Growth.

The particular Materials that will be requiſite in Building or Rebuilding Ships, are the ſame, according to their Magnitudes and Parts requir'd to be Repaired, if our Practice be with Indifference conſidered; and therefore ſince the Utenſils proper to be applied be ſo very many, as I ſhall fully ſhow hereafter, they ought not to be increaſed through Neglect or Fancy, but by General Proportions there ſhould be abſolute Standards pitch'd upon, either in Building, Rebuilding or Equipping any Sort of Ship.

The principal Material in Building Ships is Timber, of which there are diverſe Sorts, as Oak, Elm, Beech, Aſh and Firr; all which, altho' little Diſtinction be made in the Uſe, yet they are all vaſtly different, both in the Nature and Growth.

Oak Timber being more generally uſed is more valuable, of which there is divers Sorts, tho' of all other the *Engliſh* is preferable in Ship-building; notwithſtanding there is great Variety in ours, through the Soil and Management in the ſame.

Several ingenious Naturaliſts have been copious concerning Vegetables, and the Cauſe of Growth in Trees, allowing it to conſiſt of Heat, Moiſture, and the Terreſtrial Matter, as Mold or Duſt; and that neither of the three can without the other produce or bring either Seed or Plant to Perfection; and therefore any that are over-curious in the Enquiry of ſuch Increaſe, may have Recourſe to ſuch Authors. And in this I ſhall only mention ſomething out of Maſter *Evelyn*'s *Sylva*, where he has diſcourſed very largely on the Management of Foreſt Trees, and dedicates it to King *Charles* the Second, who mightily delighted in the Art of Ship-Building.

Of

Oak. Of the Oak he ſays there are four Kinds, but the Beſt is that which is moſt ſpreading in Root and Branch, and full of Leaves; the Ground preferable for the ſame is the ſound, black, deep and faſt Mold, rather Warm than over Wet and Cold, which produces the firmeſt Timber: Tho' my Lord *Bacon* prefers that which grows in Moiſter Grounds for Ship Timber, as the moſt Tough and leſs ſubject to Rift. But *Pliny* ſays, the Trees which grow tolerably, either on Hills or Vallies, ariſe to greater Stature, and ſpread more amply in the Lower Grounds; but that Timber is far better, and of finer Grain which grows upon the Mountains; and again, the Timber of thoſe Trees which grows in moiſt and ſhady Places is not ſo good as that which comes from a more expoſed Situation, nor is it ſo, cloſe, ſubſtantial and durable.

Vitruvius notes, concerning Oak Timber, as Trees growing, that they neither proſper in very hot, nor exceſſive cold Climates; light Sand produceth the ſmoother grain'd Oak Timber, and moſt uſeful for the Joyners; but that which grows in Gravel is ſubject to be frow as it's term'd.

As to its Fitneſs for the Uſes; for Ship Work in general it's excellent, alſo for Wheel Spokes, Trenels, Pins and Pegs for Tiling, the ſmalleſt and ſtraitgheſt is beſt, diſcovered by the upright Tenor of the Bark, as being the moſt proper for Cleaving; the Knottieſt for Water-Works, Piles and the like, becauſe it will drive beſt and laſt longeſt; the Crooked, yet Firm, for Knee-Timber in Shipping, Mill-Wheels, *&c.* Were Planting of theſe Woods more in uſe we ſhould baniſh our Hoops of Hazel, and the like, for thoſe of good Coppet-Oak, which being made of the Younger Shoots, are exceeding Tough and Strong, one of them being of Ground Oak, will out laſt Six of the beſt Aſh.

Elm. Of the Elm, there are four or five Sorts, two of which are worthy our Culture, as the Mountain Elm being of a leſs jagget and ſmaller Leaf, and the *French* Elm, whoſe Leaves are thicker, and more florid and ſmooth, delighting in the lower and moiſter Ground, it being a Tree of Conſort ſociable, and ſo affected to grow in Company, that the very beſt do generally touch; it delights in a ſound, ſweet and fertile Land, ſomething more inclined to Moiſture, and is a Timber of a ſingular Uſe, eſpecially where it may lye continually Dry or Wet in Extreams, very proper for Ships Planks, under the light Draught of Water, and for ſeveral other Parts of a Ship that lyes in the Dry, ſince it's much cheaper than Oak.

The Elm which with Shipwrights is called Witch-Elm, is excellent for bending, and uſed in Building of *Deal* Yawls, which are very blunt bodied; notwithſtanding the Ground End of our *Engliſh* Oaks muſt have the preference, meaning ſuch as are uſed to make Milk Buckets, and therefore much exceeding the Eaſt Land Planks.

It is proper for Water-Works, Mills, Pipes, Pumps, alſo for Wheelwrights, the Knotty for Naves, the Straight and Smooth for Axle-trees, and the very Roots for curious dappled Works, ſcarce has any Superior for Kerbs of Coppers, Feather-edge and Weather-Boards.

Beech. Of the Beech there are two Kinds; the Mountain Beech is Whiteſt, and moſt ſought after by the Turners, but the Wild which is of a blacker Colour is more durable

The Uſe of this Wood is chiefly for Houſewifery, as for Diſhes, Trays, Rimbs for Buckets, Trenchers, Dreſſer Boards; Likewiſe for the Wheeler, Joyner and Upholſterer, for Sellys, Chairs, Stools Bedſteads, *&c.* Notwithſtanding if this Timber lyes under Water, it's little inferior to Elm. *Ricciolus* much recommends it for Oars, and ſome ſay that the vaſt Ark was Built of *Fagus*, or Beech.

Aſh. Of the Aſh: It is with us Male and Female, the one affecting the higher Grounds and the other the Plains; it's reported that there is a *Flemiſh* Aſh planted in *Lincolnſhire* by *Dutchmen*, which in ſix Years Growth is worth Twenty Shillings the Tree, they being believed to be extreamly uſeful for Oars, and to be preferable to the *New-England*; alſo for Capſtand Bars, Handſpokes; and in General, the Aſh is counted for Uſe next to the Oak it ſelf; and in Countries where there is Plenty of Oak it's counted more valuable; it ſerves the Soldier, the Carpenter, Wheelwright, Cartwright, Oars, the beſt for Blocks, Pulleys and Shivers, as Seamen term them; alſo for the Cooper, Turner and Thatcher, Handles and Stocks for Tools.

Fir. Of the Fir and Pine. There are of Fir two principal Species, the Male which is of the bigger Trees, moſt Beautiful and Tapering, and of a harder Wood. The Female which is much Softer and Whiter, tho' Whiteneſs is not the beſt Character; that which knowing Workmen call the Dram, which comes from *Bergen*, *Swinſound*, &c. Long, Straight, Clear, and a Yellow more Cedry Colour is eſteem'd much before the White for Flooring and Wainſcot, for Maſts, *&c.* thoſe of *Pruſſia* which are called *Spruce*, and *Norway* (eſpecially from *Gottenberg*) are the beſt, notwithſtanding the *New-England* is Larger than any of them.

In the *Scottiſh* Highlands are Trees of wonderful Altitude, tho' not altogether ſo Thick, Tall, or Fine as thoſe of *New-England*, but growing upon Places ſo unacceſſible and far from the Sea, they are almoſt altogether paſt being brought from thence whole.

It's reported that there are Trees grown, in *Northumberland*, in few Years, big enough for a Ship's Maſt, which ſeems to import that there is no ſuch Neceſſity to be beholding to other Countries for ſuch Utenſils.

Pine. The Pine (they are reckoned of ten Sorts, preferring the Domeſtick or Stative, for the fuller Growth) is of both Sexes, whereof the Male growing Lower is more Knotty and Rude than the Female, Tar being made of Pine-Tree, from which naturally Turpentine Extilleth, which at its firſt flowing out is Liquid and Clear, but being hardned by the Air is not much unlike the *Burgundy* Pitch; however I ſhall ſpeak more largely on this Subject when I come to the Material produced by the ſaid Timber.

Cypreſs and Cedar. Maſter *Evelyn* puts Cypreſs and Cedar into one Chapter, giving ſeveral Reaſons that it muſt be Cypreſs which the Ark was built with; and to inforce it he tells you that ſeveral Travellers relate, that there is no other Sort of Timber fit for Shipping ſo frequent as this Tree about thoſe Parts of *Aſſyria*, where the Ark is conjectur'd to have been Built. Notwithſtanding it is alſo believed to have been great Part built of Cedar, or what is ſo termed by the *Turks* that make uſe of ſuch Machines that Ark originally imitated.

He alſo mentions of the Cedar, that it grows in all Extreams, in the moiſt *Barbados*, the hot *Bermudos*, and the cold *New-England:* why then it ſhould not thrive in Old *England* I conceive is from our Want of Induſtry, ſince the Uſe and Value of ſuch large Maſts for our biggeſt Shipping is ſo very much.

Mr. *Evelyn* mentions, that in *Scotland* there is a moſt beautiful Sort of Fir grows upon the Mountains which belonged to the Marqueſs of *Argyle*.

Pine. It's very uſeful for Ships Maſts, Sheathing-Board, Scaffold or Stage Poles, Standers as Shipwrights term them; nay heretofore the whole Ship was compoſed with Fir, for Wainſcot, Floors, Pales, Balks, Laths, Boxes; it's excellent to Poliſh on, to Carve on, and no Wood takes the Glue better. It's excellent for Beams and other Timber Work in Houſes, being both Light and very Strong; but referring to Mr. *Evelyn*'s *Sylva*, where a very large Account of all Fir Timber is fully ſet down.

Of the Service. This Timber is uſeful for the Joyner, Engraver, Pulleys, Skrews and Mill-Spindles.

Maple, this Timber is far ſuperior to Beech for all Uſes of the Turner.

Alder, the Poles of Alder are as uſeful as thoſe of Willows; the Wood is likewiſe uſeful for Piles, Pumps, Hop-Poles, Water-Pipes, Troughs, *&c.*

Lotus is another Lover of the Water; of this Timber is made Pipes and Wind Inſtruments.

Cornel Tree. But the Cornel Tree, which is in the ſame Chapter, is exceedingly commended for its Durableneſs, and Uſe in Wheel Work, Pins and Wedges, in which it laſts like the hardeſt Iron, and will grow with us to good Bulk and

Stature. And ſo I end this Obſervation of deſcribing the Uſefulneſs of ſeveral Sorts of Wood, having only mention'd ſuch as I find preferred for Shipwork, and ſome other Uſes, that may be incident to the ſame; and ſuch as are over curious in the Enquiry on this Subject may be fully ſatisfy'd in that Volume, and I proceed to mention ſomething of the Infirmities of Trees.

The Diſeaſes of Trees are various, according to the Ruſtick Rhine.

The Bodies of Trees are viſited with Cankers, Hollowneſs, Hornets, Earwigs, Snails, *&c.*

The Wind-ſhock is a Bruiſe and Shiver throughout the Tree, tho' not conſtantly viſible, yet leading the Warp from ſmooth Renting, cauſed by powerful Winds when Young, and perhaps by ſubtle Lightnings: The beſt Prevention is Shelter, choice of Place for the Plantation, frequent Shreading whilſt they are yet in their Youth.

Cankers cauſed by ſome Strokes or Galling, are to be cut out to the Quick, the Scars emplaiſter'd with Tar mingled with Oil, and over that a thin ſpreading of Loam.

Hollowneſs is contracted when, by Reaſon of the ignorant or careleſs Lopping of a Tree, the Wet is ſuffered to fall perpendicularly upon a Part, eſpecially the Head; in this Caſe, if there be ſufficient ſound Wood, cut it to the Quick and cloſe to the Body, and Cap the hollow Part with a Tarpaulin, or fill it with good ſtiff Loam and fine Hay mingled; this is one of the worſt of Evils and to which the Elm is moſt obnoxious.

Bending of Trees, eſpecially Oak or Aſh when they are Young, into various Flexures, Curbs and Poſtures, will oblige them to ply themſelves into different Shapes and Modes, which may be done by humbling them with Tough-Bands, and Withes or Hooks rather, cut Screw-wiſe, or ſlightly Hagled and indented with a Knife, and ſo ſcrewed into the Ground, till the Tenor of the Sap and Cuſtom of being ſo conſtrain'd, render them apt to grow ſo themſelves, without Power of redreſſing; which Courſe would wonderfully accommodate Materials for Knee Timber in Shipping, and other Uſes, conform it to the Moulds, and ſave infinite Labour, and abbreviate the Work of Hewing and Waſte.

The Poet it ſeems knew it well and for what Purpoſes;

When in the Wood, with mighty Force, they bow
The Elm, and ſhape it, to a Crooked Plow.

ſo as it even half made it to their Hands.

Theſe Inſtances are really very commendable in ſuch a worthy Gentleman as Maſter *Evelyn*, who could not be any way biaſs'd to give ſuch a Caution, which being minded would prove very beneficial to theſe Kingdoms; and it is really admirable to ſee ſuch a Man, that I am almoſt poſitive had not any Dealing in the Trade of Ship Building, gueſs ſo very luckily as if he had been a Practitioner, and how he endeavour'd by all proper Motives to redreſs that abominable Fault of waſting ſuch a valuable Material; and others who may amend it much eaſier, run directly counter to his Advice and waſte all they can.

A Breviate of the Age, Stature, and Felling of Trees.

Pliny tells us of ſome Oaks in his Time growing in the *Hercynian* Foreſt, which were thought co-evous with the World it ſelf, their Roots had even raiſed Mountains, and where they encountred ſwell'd into goodly Arches, like the Gates of a City. The *Germans* (as now the *Indians*) had of Old ſome Punts or Canoes of excavated Oaks, which would well contain thirty, ſome forty Perſons.

He mentions Elm-Trees that will hold three Foot Square for more than forty Foot Height, growing in moiſt Gravel and in a Hedge Row, and Oaks of 40 Foot high and 5 Foot Diameter. Of Oaks near *Newbury* of 50 Foot Height, without a Bough or Knot, and cut 5 Foot Square at the Butt End: and of an Oak called the Queen's Oak, 40 Foot high, Straight as an Arrow in Growth and Grain, cutting four Foot at the Stub, and near a Yard at the Top; this Oak was of a Kind ſo excellent, cutting a Grain as Clear as Clap-board: and of an Oak that grew about *Framingham* in *Suffolk*, that made four Beams entire, from Side to Side, for the *Royal Soveraign*; the Tree was four Foot nine Inches Diameter: And after Abundance of Precedents he produces for admirable large Trees; he paſſes on, and inſtances the Nature of the Growth, from Cutting or Dividing a Tree Traverſe-wiſe, where you may obſerve a certain Number of Circles or Diviſions, made between the Center and Bark of the Tree, believing that every Year produces a new one; for by cutting a Tree in the new Foreſt that had three or four Hundred of ſuch Diviſions, it was believed that Tree was as many Years Old ſave One.

Such Rings or Spaces appearing upon Tranſverſe Section (as they appear Eliptical upon Oblique, and Straight Lines upon direct Section) are no other than the Extremities of ſo many Integuments (or Coverings) inveſting the whole, and, perhaps, all the Boughs that are of the ſame Age with any of them or Older.

The Growth of Trees Augmentation in all Dimenſions, is acquired not only by Acceſſion of a new Integument Yearly, but alſo by the Reception of Nouriſhment into the Pores.

The Time of the Year for Felling Trees is not uſual till about the End of *April* (at which Seaſon the Bark doth generally Riſe freely) tho' the Opinions of Men, and alſo the Practice has been very different. *Vitruvius* is for an Autumnal Fall. Others Adviſe *December* and *January*. *Cato* was of Opinion Trees ſhould have firſt born their Fruit, or at leaſt not till they were full ripe, which argrees with that of the Architect. And tho' Timber unbarked be indeed more obnoxious to the Worm, and to contract ſomewhat a darker Hue, (which is the Reaſon ſo many have commended the Seaſon, when it will moſt freely Strip) yet was this to be rather conſidered for ſuch Trees as one would rather leave Round and Unſquared; ſince we find the wild Oak, and many other Sorts, fell'd over late, and when the Sap begins to grow proud, to be very ſubject to the Worm; whereas being cut about Mid-winter, it neither Caſts, Rifts, nor Twines, becauſe the Cold of the Winter doth both Dry and Conſolidate, whilſt in Spring, and when pregnant, ſo much of the Virtue goes into the Leaf and Branches. Happy therefore was it for our Timber, if ſome real Invention of Tanning without ſo much Bark (as the Honourable Mr. *Charles Howard* has moſt ingeniouſly offered) were become Univerſal, that Trees being more early fell'd the Timber might be better ſeaſoned and conditioned for its variout Uſes: But, as the Cuſtom is, Men have now Time to fell their Woods from Mid-winter to the Spring, but not any after the Summer Solſtice, and the Rules are as follows.

Fell in the Decreaſe, or four Days after Conjunction of the two great Luminaries; ſome the laſt Quarter of it; or, (as *Pliny*) in the very Article of the Change, if poſſible, which happens, ſaith he, in the laſt days of the Winter Solſtice, that Timber will prove immortal; at leaſt, it ſhould be from the Twentieth to the Thirtieth Day according to *Columella*. *Cato* four Days after the Full, as far better for the Growth: Vegitives for Ship-Timber from the Fifteenth to the Twenty Fifth, the Moon as before; but never during the Increaſe, Trees being then moſt abounding with Moiſture, which is the only Source of Putrefaction; and it is affirmed, upon unqueſtionable Experience, that Timber cut at any time of the Year in the old Moon, or laſt Quarter, when the Wind blows Weſterly, proves as ſound and good as at any other Period whatſoever, nay all the whole Summer long, as any Months of the Year; which for that it may be of great Uſe to ſome I thought fit to communicate.

Then for the Temper and Time of the Day, the Wind low, neither Eaſt nor Weſt (but Weſt of the two) the Eaſt being moſt pernicious and expoſing it to the Worm, for which the beſt Cure is the plentiful Sobbing of it in Water, neither Froſty, Wet, or Dewy Weather, and therefore never in a Forenoon.

When the Timber is thus Fell'd, Stript, Lopp'd and truly Squar'd, the next material Caſe is to Meaſure it right, for which I ſhall refer my Reader to the Writings of ſeveral Mathematical Authors, being purely bent in this Treatiſe to mention as little as poſſible of what can be obtain'd in other Books: I therefore recommend what the induſtrious Mathematician Mr. *Leyborn* has publiſh'd in his late *Line of Proportion made eaſy*, and other his Labours: However I ſhall, for the Benefit of young Practitioners, inſert the Tables concerning Meaſuring of Timber, which I found in *Sylva*, and endeavour to make them more Intelligible to the Unlearn'd.

The Square of the Timbers End conſidered as Timber equal in Bigneſs from one End to another, altho' it may ſuffice for the Meaſuring Place of tapering Timber.

Ft.	In.	Ft.	In.	Pts.
0	6	4	0	0
0	7	2	11	2
0	8	2	3	0
0	9	1	9	3
0	10	1	3	3
0	11	1	2	3
1	0	1	0	0
1	1	0	10	2
1	2	0	8	8
1	3	0	7	6
1	4	0	6	7
1	5	0	5	9
1	6	0	5	3
1	7	0	4	8
1	8	0	4	3
1	9	0	3	9
1	10	0	3	5
1	11	0	3	3
2	0	0	3	0
2	1	0	2	8
2	2	0	2	6
2	3	0	2	3
2	4	0	2	2
2	5	0	2	1
2	6	0	1	9
2	7	0	1	8
2	8	0	1	7
2	9	0	1	6
2	10	0	1	5
2	11	0	1	4
3	0	0	1	3

The Length of a Foot Solid in Feet and Inches, and Parts of Inches from the Square in the two firſt Columns.

This Table was prepared purely to confute that Erroneous Cuſtom, which was made uſe of in taking the ¼ Part of the Girt for the true Square of the Tree, as I ſhall prove by one or two Examples. Firſt, In the Column towards the Left-hand take 1 Foot, and in the Second 3 Inches, which together is 15 Inches, the ¼ of 60 Inches; you will then find oppoſite to that in the 5th and 6th Columns, 7 Inches *6* Parts, which is ſomewhat above 7 Inches and ½ an Inch, which is the Length of a Piece of 19 Inches ½. Diameter, to make a Square Foot or 1728 Inches, — near it.

The Side of the Square equal to the Diameter, is as 12 to 13 ½, ſo that the Square of this Tree is 17 Inches; then look for one Foot in the firſt Column, and in the ſecond Column 5 Inches; then oppoſite to that in the 5th and 6th Columns you will find 5 Foot 9 Parts, which is the Length of a Tree of 19 Inches, ½. Diameter, which will make a Square Foot, *Fecit.*

So that inſtead of taking ¼ of the Girt for the Square of the Tree, Work your Proportion as aforeſaid, from which Proportion I ſhall Calculate a Table for to find the true Square of any Round Tree, from a Tree of 6 Inches Diameter, to one of 36 Inches Diameter; and then ſhew you in what Place, from the biggeſt Part of the Tree, the Girt ought to be taken, inſtead of taking it exactly in the Middle of the ſame.

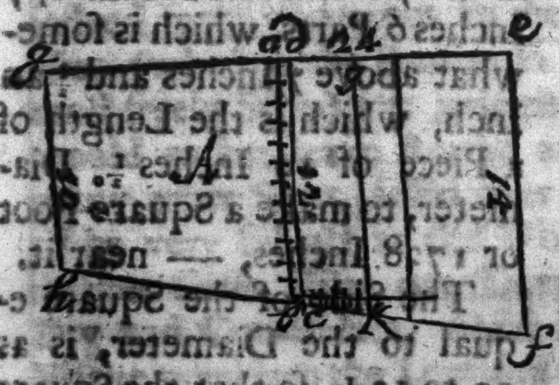
This

Inches Diameter of a rough Tree when the Bark is off.	The Square equal to make the same Contents as half the Circumference, and half the Diameter will do multiplied one into the other.
6	5 $\frac{3}{10}$
7	6 $\frac{2}{10}$
8	7 $\frac{1}{10}$
9	8
10	8 $\frac{9}{10}$
11	9 $\frac{8}{10}$
12	10 $\frac{7}{10}$
13	11 $\frac{6}{10}$
14	12 $\frac{1}{2}$
15	13 $\frac{3}{10}$
16	14 $\frac{2}{10}$
17	15 $\frac{1}{10}$
18	16
19	17
20	17 $\frac{8}{10}$
21	18 $\frac{7}{10}$
22	19 $\frac{6}{10}$
23	20 $\frac{1}{2}$
24	21 $\frac{4}{10}$
25	22 $\frac{3}{10}$
26	23
27	24
28	25
29	25 $\frac{7}{10}$
30	26 $\frac{6}{10}$
31	27 $\frac{4}{10}$
32	28 $\frac{4}{10}$
33	29 $\frac{4}{10}$
34	30 $\frac{2}{10}$
35	31
36	32

This Table is ready calculated for Meaſuring rough Timber that is not truly Squar'd, the firſt Column ſhewing the Diameter of the Tree, and the Second the Square equal to that Diameter; ſo that multiplying the Squares one into the other will be equal to the Area made by Multiplying half the Diameter by half of its reſpective Circumference. I proceed now to ſhew that the Middle of tapered Timber is not the true Place of Meaſuring it. Obſerving once a Queſtion that was ſtarted amongſt Shipwrights by a Perſon of a different Occupation, which was as follows.

Provided a Piece of Timber was two Foot long, and 14 Inches Square at the great End, and 10 Inches Square at the ſmall End, to know how many ſolid Inches of Timber it contains. The Middle of 14 and 10 is 12, ſo that, as Cuſtome, the Piece ſhould contain twice 1728 Inches, which is 3456; but ſuch a Piece, according to true Meaſure, contains 3488 Inches, 32 Inches more than what is produced by the Middle Girt.

As in the Figure *A*, you may Obſerve that from *g* to *e* I ſuppoſe to be 24 Inches long, the Baſe *e f* 14 Inches Square, and *g h* 10 Inches Square; then the Middle of the Piece *a b* is directly 12, which 12 being × into it ſelf is 144. And again × by 24 is 3456, but × 12·1 into it ſelf it is 146·41, which × by 24 is 3513·84, which is near as much the other way; ſo that 12-$\frac{06}{100}$ is the neareſt Number to be ×, which being again × by 24 is 3490·6, and then the true Place of Meaſure will fall near the Middle between *a b*, and *c d*: tho' Mr. *Alingham*, in his Epitomy of Geometry ſays that one third of any rough tapered Piece of Timber, from the great End, is the true Place of Meaſure, which in this Piece would be at *l K*, which would be 12-$\frac{6}{10}$. this × by it ſelf is 158·7, and again × by 24, is 3810·2, which would be 354 Inches more than the Truth, and conſequently ſwell in other Pieces according to the Bulk; and therefore ſince the Shape of Timber is ſo very various, it would be moſt proper for them that reſolve to meaſure exact, Firſt to reduce the Shapes to ſuch Figures as I have here deſcribed, and from thence they would obtain the Truth of the Content, only meaning for them to take the Difference of the Top and But, and make out a Figure as I have done here.



The Square of the Tree in Inches and Parts. *Note* that the Croſs ſhort Lines between the Figures 1—2—3, are half Inches.

The Length of the Timber rough in Feet.

	Col. 1.		Col. 2.		Col. 3.		Col. 4.		Col. 5.	
	Ft.	Pts	Ft.	Pts.	Ft.	Pts.	Ft.	Pts	Ft.	Pts
—	0	00	0	00	0	00	0	01	0	01
1	0	01	0	01	0	02	0	03	0	03
—	0	01	0	03	0	05	0	06	0	08
2	0	03	0	05	0	08	0	11	0	14
—	0	04	0	08	0	13	0	17	0	21
3	0	06	0	12	0	18	0	25	0	31
—	0	08	0	17	0	25	0	34	0	42
4	0	11	0	22	0	33	0	44	0	55
—	0	14	0	28	0	42	0	56	0	70
5	0	17	0	35	0	52	0	69	0	81
—	0	21	0	42	0	63	0	84	1	05
6	0	25	0	50	0	75	1	00	1	25
—	0	29	0	58	0	88	1	17	1	46
7	0	34	0	68	1	02	1	36	1	70
—	0	39	0	78	1	17	1	56	1	95
8	0	44	0	89	1	33	1	77	2	22
—	0	50	0	99	1	50	1	01	2	51
9	0	56	1	12	1	68	2	25	2	81
—	0	63	1	25	1	88	2	51	3	13
10	0	69	1	39	2	08	2	47	3	47
—	0	76	1	53	2	29	3	06	3	82
11	0	84	1	68	2	52	3	36	4	20
—	0	92	1	84	2	76	3	67	4	59
12	1	00	2	00	3	00	4	00	5	00
—	1	08	2	17	3	25	4	34	5	42
13	1	17	2	35	3	51	4	69	5	87
—	1	26	2	53	3	80	5	06	6	33
14	1	36	2	72	4	08	5	44	6	80
—	1	46	2	92	4	38	5	80	7	30
15	1	55	3	12	4	68	6	25	7	81
—	1	67	3	23	5	00	6	67	8	34
16	1	78	3	55	5	33	7	11	8	89
—	1	89	3	78	5	67	7	56	9	45
7	2	01	4	01	6	02	8	03	10	03
—	2	13	4	25	6	38	8	51	10	63
18	2	25	4	50	6	75	9	00	11	25

This Table ſhews you that in a Tree of 36 In. Circumference, by taking ¼ of 36, or 9, enter at the Left Hand Column, and oppoſite to it, under the Column 3, which Chalks out the Length, you will find 1-68; ſo that a Tree of 36 Inches about, and 3 Foot long, contains 1 Foot $\frac{68}{100}$, and ⅕ is ſtill allowed for Waſte.

The Square of the Tree in Inches and Parts.

The Length of the Timber in Feet.

	Col. 6.		Col 7		Col. 8.		Col. 9.		Col. 10	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
—	0	01	0	01	0	01	0	02	0	02
1	0	04	0	05	0	05	0	06	0	07
—	0	09	0	11	0	13	0	14	0	16
2	0	17	0	19	0	22	0	25	0	28
—	0	26	0	30	0	34	0	39	0	43
3	0	37	0	43	0	49	0	56	0	62
—	0	51	0	59	0	68	0	76	0	85
4	0	66	0	78	0	89	0	99	1	11
—	0	84	0	98	1	12	1	26	1	40
5	1	04	1	22	1	39	1	56	1	74
—	1	26	1	47	1	68	1	89	2	10
6	1	50	1	55	2	00	2	25	2	50
—	1	76	2	05	2	34	2	64	2	93
7	2	04	2	38	2	72	3	05	3	40
—	2	34	2	73	3	12	3	51	3	90
8	2	66	3	11	3	55	3	99	4	44
—	3	01	3	51	4	01	4	52	5	02
9	3	37	3	93	4	49	5	06	5	62
—	3	76	4	29	5	01	5	64	6	27
10	4	16	4	86	5	55	6	24	6	94
—	4	59	5	35	6	12	6	88	7	65
11	5	04	5	88	6	72	7	56	8	40
—	5	51	6	43	7	35	8	27	9	19
12	6	00	7	00	8	00	9	00	10	00
—	6	51	7	51	8	68	9	76	10	85
13	7	04	8	22	9	39	10	56	11	74
—	7	59	8	86	10	13	11	39	12	6
14	8	16	9	53	10	89	12	25	13	61
—	8	76	10	22	11	68	13	14	14	60
15	9	37	10	93	12	49	14	06	15	62
—	10	01	11	67	13	34	15	01	16	68
16	10	67	12	44	14	22	16	00	17	78
—	11	34	13	24	15	13	17	02	18	91
17	12	04	14	05	16	05	18	06	20	07
—	12	75	15	89	17	01	19	14	21	27
18	13	50	16	75	19	00	20	25	22	50

This Table is a Continuance of the other, as in Caſe you would know the Content of a Timber Tree, which was 60 Inches about, and 9 Foot long; the ¼ of 60 is 15, enter with 15 in the Left hand Column, and under 9 Foot at the Head Column, you will find 14 Foot $\frac{06}{100}$ Part, which is the Content of ſuch a Tree, when ⅕ Waſte is allowed.

Square of the Tree in Inches and Halves of Inches.	The Length of the Timber.									
	1		2		3		4		5	
	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.
—	2	38	4	75	7	13	9	51	11	88
19	2	51	5	01	7	52	10	03	12	53
—	2	64	5	28	7	82	10	56	13	20
20	2	78	5	55	8	33	11	11	13	89
—	2	92	5	83	8	75	11	67	14	59
21	3	06	6	12	9	18	12	25	15	31
—	3	21	6	42	9	63	12	84	16	05
22	3	36	6	72	10	08	13	44	16	80
—	3	51	7	03	10	55	14	06	17	58
23	3	67	7	34	11	02	14	69	18	36
—	3	83	7	67	11	50	15	34	19	17
24	4	00	8	00	12	00	16	00	20	00
—	4	16	8	33	12	50	16	66	20	83
25	4	34	8	68	13	02	17	36	21	70
—	4	51	9	02	13	54	18	05	22	56
26	4	69	9	39	14	08	18	75	23	47
—	4	88	9	75	14	63	19	51	24	38
27	5	06	10	12	15	19	20	25	25	31
—	5	25	10	50	15	75	21	00	26	25
28	5	44	10	89	16	33	21	78	27	22
—	5	67	11	34	17	01	22	68	28	25
29	5	84	11	68	17	52	23	36	29	20
—	6	04	12	08	18	13	24	17	30	21
30	6	25	12	50	18	75	25	00	31	25
—	6	46	12	92	19	38	25	84	32	30
31	6	67	13	34	20	02	26	69	33	36
—	6	89	13	78	20	67	27	56	34	45
32	7	11	14	22	21	33	28	44	35	55
—	7	33	14	66	21	99	29	33	36	66
33	7	56	15	12	22	68	30	24	37	81
—	7	78	15	56	23	34	31	12	38	90
34	8	03	16	05	24	08	32	01	40	14
—	8	26	16	52	24	79	33	05	41	31
35	8	54	17	01	25	52	34	03	42	53
—	8	78	17	50	26	25	35	00	43	75
36	9	00	18	00	27	00	36	00	44	00

In this Table entering at the Left-Hand with 25, the $\frac{1}{4}$ of 100, and under 5 at the Top, you will find 21 Foot, and $\frac{70}{100}$ Parts of a Foot, which is the Content of that Tree which is 100 Inches about, and 5 Foot long; allowing $\frac{1}{5}$ for Waſte.

Square of the Tree in Inches and Halves of Inches.	The Length of the Timber.									
	6		7		8		9		10	
	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.	Ft.	Pts.
—	14	26	16	64	19	01	21	39	23	77
19	15	04	17	55	20	05	22	56	25	07
—	15	64	18	49	21	15	23	77	26	41
20	16	67	19	40	22	22	25	00	27	78
—	17	51	20	42	23	34	26	26	29	18
21	18	37	21	43	24	49	27	56	30	62
—	19	26	22	47	25	68	28	89	32	10
22	20	16	23	53	26	89	30	25	33	61
—	21	09	24	61	28	13	31	64	35	16
23	22	04	25	71	29	38	33	06	36	73
—	23	01	26	84	30	68	34	51	38	35
24	24	00	28	00	32	00	36	00	40	00
—	25	00	29	16	33	33	37	49	41	66
25	26	04	30	38	34	71	39	06	43	40
—	27	08	31	59	36	10	40	62	45	13
26	28	16	32	86	37	55	42	24	46	94
—	29	26	34	14	39	01	43	89	48	77
27	30	38	35	44	40	50	45	57	50	63
—	31	50	36	75	42	00	47	25	52	50
28	32	67	38	11	43	56	49	00	54	45
—	34	02	39	69	45	36	51	03	56	70
29	35	04	40	88	46	72	52	96	58	40
—	36	26	42	30	48	34	54	09	60	43
30	37	50	43	75	50	00	56	25	62	50
—	38	74	45	22	51	68	58	14	64	60
31	40	04	46	71	53	36	60	06	66	15
—	41	36	48	23	55	11	62	01	68	00
32	42	66	49	78	56	89	63	99	71	11
—	43	99	51	33	58	65	65	99	73	33
33	45	37	52	93	60	49	67	06	75	62
—	46	68	54	46	62	24	69	02	77	80
34	48	17	56	19	64	22	71	25	80	28
—	49	58	57	84	66	10	73	37	82	63
35	51	04	59	55	68	05	75	56	85	07
—	52	50	61	25	70	00	77	75	87	50
36	54	00	63	00	72	00	61	00	90	00

Entering this Table at 30 in the Left-hand Column, being $\frac{1}{4}$ of 120, and under 10 at the Top you find 62 Feet $\frac{50}{100}$, or $\frac{1}{2}$ a Foot, and ſo much that Tree contains, which is 120 Inches about at the Meaſuring Place, and 10 Foot long, allowing $\frac{1}{5}$ Waſte.

The four laſt Tables ſhew the Content of rough Trees, according to the Cuſtom of allowing $\frac{1}{4}$ of the Girt at the Meaſuring Place to be the true Square of the Tree. The firſt Column towards the Left-hand ſhews you the Square in Inches and half Inches; and the Top as 1, 2, 3, 4, 5, again, 6, 7, 8, 9, 10, ſhews the Length in Feet, and the five Columns ſhews you the Content of each Tree, according as they have Reference from each reſpective Squares and Lengths contained in the ſame.

But ſuppoſing (as they ought to do) there was no ſuch Waſte as is pretended, you will find by what I have laid down preceeding theſe Tables how much in Length of any Cylindrical Timber, whoſe Girt is known, will make a Foot Solid, and conſequently the true Meaſure of any rough Tree will be exactly found. However, for the more entirely detecting the Errors of former Cuſtoms, I ſhall enter another Table of the ſame Nature, which I alſo found in *Sylva.*

The

Cir.	Ft.	In.	Pts.	Cir.	Ft.	In.	Pts	Cir.	Ft.	In.	Pts
10	18	11	2	51	0	8	3	92	0	2	2
11	14	11	5	52	0	8	0	93	0	2	1
12	12	6	8	53	0	7	8	94	0	2	1
13	10	8	5	54	0	7	4	95	0	2	1
14	9	2	7	55	0	7	2	96	0	2	0
15	7	10	3	56	0	6	9	97	0	2	0
16	7	0	8	57	0	6	7	98	0	2	0
17	6	3	0	58	0	6	4	99	0	1	11
18	5	7	0	59	0	6	2	100	0	1	11
19	5	0	2	60	0	6	0				
20	4	6	3	61	0	5	8				
21	4	1	2	62	0	5	6				
22	3	8	9	63	0	5	5				
23	3	4	9	64	0	5	2				
24	3	1	7	65	0	5	1				
25	2	10	7	66	0	4	9				
26	2	8	1	67	0	4	8				
27	2	5	8	68	0	4	7				
28	2	3	7	69	0	4	6				
29	2	1	8	70	0	4	4				
30	2	0	1	71	0	4	3				
31	1	10	6	72	0	4	2				
32	1	9	2	73	0	4	1				
33	1	7	9	74	0	3	9				
34	1	6	8	75	0	3	8				
35	1	5	7	76	0	3	7				
36	1	4	7	77	0	3	6				
37	1	3	8	78	0	3	5				
38	1	3	0	79	0	3	4				
39	1	2	3	80	0	3	3				
40	1	1	6	81	0	3	2				
41	1	0	9	82	0	3	1				
42	1	0	3	83	0	3	0				
43	0	11	7	84	0	2	9				
44	0	11	1	85	0	2	8				
45	0	10	7	86	0	2	7				
46	0	10	2	87	0	2	6				
47	0	9	9	88	0	2	5				
48	0	9	4	89	0	2	4				
49	0	9	0	90	0	2	3				
50	0	8	7	91	0	2	2				

The Circumference of the Tree in Inches.

The Circumference of the Tree in Inches.

The Circumference of the Tree in Inches.

This Table ſhews by the Circumference, or Girt of any Round Tree, or Cylindrical Figure, how much in Length makes a Solid Foot, or 1728 Inches. The Columns under Cir. is the Girt, or Circumference of any Tree; and the other Columns under Ft. In. Pts. ſhews the Length in Feet, Inches, and Parts, that will make a Solid Foot, according as the ſaid Length has Reference to its particular Circumference, for Inſtance.

A Tree being 60 Inches Circumference, to know what Length will be required to make a ſolid Foot.

Find 60 Inches under the Column marked Cir. and oppoſite to it, to the Right Hand you find 6 Inches, or in the Table 0 6 0 The Conſectary is that 6 Inches in Length of a Tree 60 Inches Circumference will make a Solid Foot, whereas by the other uſual Procedure, you find there muſt be ſeven Inches and above half an Inch, to make ſo much, which is one Inch and a Half too much in every Foot Length.

So ſuppoſe a Tree be 39 Inches Circumference, the ſame Table ſhews that 1 Foot 2 Inches, and $\frac{3}{10}$ Parts of an Inch in Length will go to make a ſolid Foot, and ſo of any other Number, as far as you will enlarge your Table.

But then imagining that your Sides of a Timber Tree is Oblong (at the Places of Meaſure) as it often happens, ſometimes 5, 10, or more Inches Difference; It has been formerly the Opinion of Artificers, that this Difference is encounter'd by adding the Sides together, and taking one half Part of both Sides for the true Square of the Tree; which is very Erroneous, eſpecially if the Sides differ much. I ſhall therefore add to the former Tables one I found ready calculated, which may be enlarged at Pleaſure; only firſt I will inſtance a very plain and practical Way to reform this Error on our common Two Foot Rules.

As in Caſe there was a Piece to be meaſured that was 12 Inches one Way, and four Inches the other Way, then 12 and 4 being 16, the Half is Eight, which according to the Ancient Cuſtom was took for the Square of the Piece; but if you multiply 12 by 4, it's 48, and the Square Root of which is but 6 and $\frac{37}{40}$, which is the true Square of that Piece, and ſo of any other Piece that is Oblong or Uneven: Which to prove on the Line of Numbers, vulgarly call'd *Gunter's Line*, divide with your Compaſſes one equal Diviſion betwen 12 and 5, and you will find that Center to be at $6\frac{37}{46}$, according to the Proportion of the Root; but to proceed to the Table.

In.		In.		In.		In.	
1	000000	26	141497	51	170757	76	188081
2	030103	27	143136	52	171600	77	188649
3	047712	28	144715	53	172427	78	189209
4	062206	29	146239	54	173239	79	189762
5	069897	30	147712	55	174036	80	190309
6	077815	31	149136	56	174818	81	190848
7	084509	32	150525	57	175587	82	191381
8	090308	33	151851	58	176342	83	191907
9	095424	34	153147	59	177085	84	192428
10	100000	35	154406	60	177815	85	192941
11	104139	36	155630	61	178532	86	193449
12	107918	37	156820	62	179239	87	193952
13	111394	38	157978	63	179934	88	194448
14	114612	39	159106	64	180618	89	194939
15	117609	40	160205	65	181291	90	195624
16	120411	41	161278	66	181954	91	195904
17	123044	42	162325	67	182607	92	196378
18	125527	43	163346	68	183250	93	196848
19	127875	44	164345	69	183885	94	197312
20	130102	45	165321	70	184509	95	197772
21	132221	46	166275	71	185125	96	198217
22	134242	47	167209	72	185725	97	198677
23	136172	48	168124	73	185832	98	199122
24	138021	49	169019	74	186923	99	199563
25	139794	50	169897	75	187506	100	200000

The Uſe of this Table is thus. In the Columns marked In. are the Inches contained in any Tree, and the other Numbers are a Sort of Logarithms; as ſuppoſing you had a Piece of Timber 16 Inches one Way, and 25 Inches the other Way; to find the True Square of that Piece proceed thus: Find 16 in the Column marked In. and oppoſite to it is 120411; then find 25, and oppoſite to that is 139794, which two Sums added together is 260205, the Half of which is 130102½; then in the Right-hand Columns find that Number, or the neareſt to it, which is 20 Inches the true Square of a Piece, whoſe Sides is 16 Inches one Way, and 25 Inches the other Way.

16 — 120411
Example — 25 — 139794

Sum 260205
20. 130102½

But theſe Inſtances are when a Tree holds its Bigneſs equal from End to End, which in almoſt all Timber Trees is tapering, and conſequently they are very different at the Ends in their ſeveral Bigneſs; but, as I ſaid before, the Cuſtom is to meaſure them in the Middle, or very near it, which is moſt certainly Falſe; therefore add the Square at the Butt-end and Top-end together, and take the Half for the true Square of the Tree. Example,

Suppoſe any Tree at the Butt-end be 32 Inches Square, and at the Top-end 22 Inches Square, the Sums added together is 54, the Half of which is the true Square of the Tree, with which, and the Length, you may find the juſt Content of the Tree. *Memorandum*, That altho' theſe Tables are not calculated to the largeſt Lengths and Bigneſſes that are often found in Trees, yet, with a little Conſideration, ſuch Contents may be exactly obtained in Parts, and ſo to the Main Sum; as for inſtance, in the ſecond Table, preceeding this, ſet the Caſe you had a Tree to meaſure 31 Inches Square, and 47 Foot long, have recourſe to 10 Foot an even Number, and oppoſite to 31 Inches, you will find 66.15 under the Column 10; put 66.15 down as often as there is Tens contain'd in 47 Foot, which is the Length of the Tree; then by the ſame Table the odd 7 will give you 46.71, which Sums added together is 311 Foot, 32 Parts; and by this Method you may proceed to any Length whatever.

There remains but one Operation more, and that is for Meaſuring of Planks, which will be all the Material Caſes in which our Wood-Men will ſtand in need of ſuch Tables.

The Breadth of Plank in Feet and Inches.		The Length of a Foot Square in Feet, and 10th Part of Inches.		
Ft.	In.	Ft.	In.	Pts.
0	1	12	0	0
	2	6	0	0
	3	4	0	0
	4	3	0	0
	5	2	4	8
	6	2	0	0
	7	1	8	6
	8	1	6	0
	9	1	4	0
	10	1	2	4
	11	1	1	1
1	0	1	0	0
	1	0	11	8
	2	0	10	3
	3	0	9	6
	4	0	9	0
	5	0	8	5
	6	0	8	0
	7	0	7	6
	8	0	7	2
	9	0	6	8
	10	0	6	5
	11	0	6	2
2	0	0	6	0
	1	0	5	8
	2	0	5	5
	3	0	5	3
	4	0	5	1
	5	0	5	0
	6	0	4	8
	7	0	4	7
	8	0	4	5
	9	0	4	4
	10	0	4	2
	11	0	4	1
3	0	0	4	0

The Explanation of this Table is thus. A Plank or Board being nine Inches broad to find how much in Length will make one Foot Square on the Superficies, according as all Plank and Board is meaſured. Firſt, find out 9 Inches in the firſt Column, oppoſite to that you will find 1-4-0, which imports 1 Foot, 4 Inches, 0 Parts, and ſo much in Length of any Board or Plank 9 Inches broad will make a Foot, ſo that every 16 Inches in Length of ſuch Plank is 144 Inches, or 1 Foot on the Superficies; and conſequently every 8 Inches half a Foot, and every 4 Inches $\frac{1}{4}$; and ſo if a Plank or Board be 2 Foot 3 Inches Broad, 5 Inches and $\frac{3}{10}$ of an Inch in Length, will make a Square ſuperficial Foot of Plank.

Notwithſtanding the Sliding Rule, commonly called the *Sliding Gunter*, is a moſt familiar Method to caſt the Meaſuring of any Sort of Plank or Timber, which Rulers you may have at moſt Inſtrument-makers, with Books of Directions; there is alſo a Volume written by one *William Darling*, called *The Carpenter's Rule made Eaſy*, which has ſeveral eaſie and very familiar Calculations concerning the Meaſuring of ſolid, or ſuperficial Timber or Plank.

If you are to remove your Timber, let the Dew be firſt off, and the South-wind blow before you draw it; neither ſhould you by any Means put it to uſe in leſs than three or four Months after: Now, if there be ſuch neceſſary Cautions requiſite in Curing and Managing of Timber, there will be others alſo required in the due Application thereof; but to proceed,

The Opinion to make excellent Plank or Boards is, that you ſhould bark your Timber in a proper Seaſon for Stripping, and ſo let them ſtand Naked a full Year before the Felling, and in ſome Caſes and Grounds it may be profitable. However ſure I am, that if Timber was continued ſtanding (until the Sap was down in the Root) after the Bark was off, it would add to its Duration ſome Years; nay, I might venture to ſay near as long again as it's found to do by the preſent Cuſtom of Cutting and providing ſuch large Quantities of Timber, and letting of it lye until it's almoſt, or quite periſhed, before it is put to its proper Uſe.

Of Timber, the Seaſoning and Uſes. Lay it up Dry, in an Airy Place, (yet out of the Wind and Sun) not ſtanding upright, but lying along, one Piece upon another, interpoſing ſome ſhort Blocks between them to preſerve them from a certain Mouldineſs, which they uſually contract whilſt they ſweat, and which frequently produces a kind of Fungus, eſpecially if there be any ſappy Parts remaining.

Some there are yet who keep their Timber as moiſt as they can by ſubmerging it in Water; amongſt Wheelwrights the Water Seaſoning is of eſpecial Regard, and ſuch Eſteem amongſt ſome, that it's certain the *Venetians*, for their Proviſion in the Arſenal, lay their Oak ſome Years in it before they employ it.

Elm ſell'd never ſo Green for ſudden Uſes if plung'd four or five Days in Water (eſpecially ſalt which is beſt) obtains an admirable Seaſoning, and may immediately be uſed; I have really obſerved it by Beech Planks that were cut juſt out of the Foreſt, and being laid four or five Days in Salt Water, were uſed and never ſhrunk, and that to moſt Timber it contributes much to its Duration.

Timber which is cleſt is nothing ſo obnoxious to riſt and cleave as what is hewn, nor that which is Squar'd as that which is round; and therefore where Uſe is to be made of high and maſſy Columns, let them be bored thro' from End to End, it is an excellent Preſervative from Splitting, and not unphiloſophical.

Tis affirmed that the old Oak, old Walnut, and young Aſh, are beſt for moſt Uſes; nay, it is a general Opinion that the Timber which is moſt ponderous is beſt eſteemed for the Uſes which require the longeſt Duration, meaning ſuch as lying long makes deepeſt Impreſſion in the Earth or in the Water being floated; alſo what is without Knots yet firm and free from Sap: For the Growth, that Timber is eſteemed beſt which grows moſt in the Sun, and on a dry and hale Ground, for thoſe Trees which ſuck and drink little are moſt hard and robuſt, and longeſt Lived; Inſtances of Sobriety, the Climate contributes much to its Quality, and the Northern Situation is preferred to the reſt of the Quarters.

Oak is eſteem'd beſt for Ships and Houſes; (or more minutely) the Elm for the Keel, the Robur for the Prow, Walnut for the Stern, Elm the Pump, Cornel Holly for Pins, or Trenels and Wedges.

Several Experiments concerning breaking diverſe Sorts of Wood, as Fir, Oak and Aſh, each an Inch Square or Thick, and 2 Foot long; the Fir weighed 8 Ounces, and was broken with 200 *l.* Weight; the Oak weighed 12 Ounces ¾, and was broken with 250 *l.* weight; the Aſh weighed 10 Ounces ⅓, and was broken with 325 *l.* weight; and from ſuch Experiments it was obſerved and confirmed that in ſimilar Pieces the Proportion of breaking by Weights is according to the Baſis of the Wood broke.

There were ſeveral other neceſſary Experiments made before the Royal Society when my Lord *Brounker* was Preſident; (and inſtanced in *Sylva*) his Lordſhip was alſo deſired by ſome of the Members to contribute towards the Proſecution thereof, and particularly to conſider what Curve Line any Ship's Beam muſt be cut in, and how thick it ought to be at the Extreams, to be equally as ſtrong as the Middle, but that was not found Entered. However, I ſhall calculate a Table to ſhew the Strength of Timber of different Length and Bigneſs, and yet to be equally Strong, which may help our Converſions, and properly adapting ſeveral Pieces of valuable Timber in a Ship, from a Piece of 4 Inches Square, to one of 34 Inches Square, and a Piece of 16 Foot long, to one of 46 Foot long, which are the Pieces moſt Valuable, and ofteneſt in uſe.

Firſt

First Table.

Square of the Timber in Inches and half Inches.	The Area of the Pieces in Inches and Parts.	Length in Feet of the ſeveral ſized Pieces, to make them of equal Strength; ſo that a Piece of Timber of 4 Inches Square and 16 Foot long, is equal in Strength to one of 17 Inches ſquare, and 290 Foot long.
4	16	16
—	20¼	20¼
5	25	25
—	30¼	30¼
6	36	36
—	42½	42½
7	49	49
—	56½	56½
8	64	64
—	72½	72½
9	81	81
—	90	90
10	100	100
—	110¼	110¼
11	121	121
—	132	132
12	144	144
—	157	157
13	169	169
—	183	183
14	196	196
—	210	210
15	225	225
—	236	236
16	256	256
—	273	273
17	290	250

Second Table.

The Length of ſeveral Pieces of Timber in Feet.	The Square of ſuch Trees in Inches to make them equally ſtrong with ſuch Lengths.	The Area of the ſeveral Pieces in Inches.
46	20	400
45	19 8/10	391
44	19 5/10	381
43	19 3/10	372
42	19 1/20	364
41	18 17/20	355
40	18 6/10	346
39	18 3/10	337
38	18 1/10	328
37	17 9/10	319
36	17 4/10	303
35	17 3/20	294
34	16 9/10	285
33	16 6/10	276
32	16 7/20	267
31	16 1/20	258
30	15 8/10	250
29	15 11/20	242
28	15 3/10	234
27	15	225

Second Table.

Length in Feet continued.	The Square in Inches continued, to make equal Strength.	Area of the ſeveral Pieces in Inches.
26	14 8/10	218
25	14 9/20	208
24	14 1/10	199
23	13 8/10	190
22	13 11/20	182
21	13 2/10	174
20	12 9/10	166
19	12 5/10	157
18	12 3/20	148
17	11 17/20	140
16	11 5/10	132

Third Table.

Square of the Timber in Inches and Halves.	The Area of the ſeveral Pieces in Inches.	Length in Feet of the ſeveral ſized Pieces to make them of equal Strength, ſo that a Piece of 18 Inches ſquare and 16 Foot long, is equal in Strength to a Piece of 34 Iuches ſquare and 55 Foot long, and 1/10 of a Foot.
18	325	16
—	342	16 4/10
19	361	17 3/10
—	380	18 4/10
20	400	19 2/10
—	420	20 2/10
21	441	21 2/10
—	462	22 2/10
22	482	23 2/10
—	507	24 2/10
23	530	25 2/10
—	555	27
24	576	28
—	600	29 2/10
25	625	30 4/10
—	650	31 6/10
26	676	33 1/10
—	702	34 5/10
27	729	35 6/10
—	755	36 8/10
28	784	38
—	810	39 2/10
29	841	40 6/10
—	870	42 4/10
30	900	43 5/10
—	931	45
31	961	46 5/10
—	993	48
32	1024	49 2/10
—	1058	51 2/10
33	1089	53
—	1123	54 4/10
34	1156	56 1/10

Theſe Tables have Reference to ſome Obſervations which I mention'd in my *Ship-Builder's Aſſiſtant* concerning the Strength of Timber, that it was according to the Square of its Sides; provided the Pieces was of equal Length; but if not, the Property is certainly altered; as you may ſee in the firſt Table, where the Firſt Column towards the Left-hand is the Square of ſeveral Pieces of Timber; and in the Second Column is the Area, or the Sides, × one into another, or ſquared; the Third Column ſhews the Length in Feet to make ſuch different Pieces of Timber in Bigneſs to be of equal Strength; you may alſo obſerve that the Lengths Augmentations is directly the ſame with the Area, which may be a general Maxim in ſuch Caſes, that if any Piece of Timber's Length is advanced according to the Swelling of the Area, or Sides of the Pieces, × one into the other, the Strength will be ſtill equal, and what is ſaid of the Firſt Table will be alſo applicable to the Third, ſince they are of the ſame Nature.

The Second Table ſhews you in the firſt Column the Length of diverſe Pieces of Timber, from 46 Foot long to 16 Foot long: The Second Column ſhews you the Sides of the Pieces to make them of equal Strength; ſo that a Piece of 46 Foot long, and 20 Inches ſquare, is equal in Strength to one of 27 Foot long and 15 Inches; alſo to one of 16 Foot long, and 11 Inches $\frac{6}{10}$ Square; and ſuch Tables, well conſidered, will be extream uſeful towards ſcantling our Shippings Frame, according to the various Tapering of their Bodies, and Strength requiſite in the ſame.

Some Remarks on the Laws and Statutes for Preſerving and Improving Woods, &c.

'Tis not to be paſſed by that the very firſt Law we find which was promulg'd was concerning Trees; and that Laws themſelves were firſt written upon them, or Tables compoſed of them, and after that eſtabliſh'd in Paradice, the next we meet withal are as ancient as *Moſes*.

A Law confirmed by the 13th and 27th of Qu. *Eliz.* cap. 25. 19, which particularly exempts Timber of 22 Years growth from Tythes, for a longer Period, to render it compleat and more effectual to their Improvements. By an ancient Law of ſome Nations it is Loſs of Hand to the Perſon that beheads a Tree without Permiſſion of the Owner; and, ſays Mr. *Evelyn*, I cannot ſay they are ſharp ones when I compare the Severity of our Laws againſt Mare-ſtealing; nor am I by Inclination the leaſt Cruel; but I do affirm *England* may as well live without Mares, as without Maſts and Ships, which are our Wooden but no leſs Profitable Horſes.'

Such Cautions as theſe are very commendable in a Gentleman that in all likelihood was unbiaſs'd to the Preſervation of Timber growing, and before it was fell'd, and I heartily wiſh he had been as great a Practitioner (as Philoſopher) in the Uſes and Application of Timber, that he might as well have caution'd our Preſerving of Timber after it was fell'd, and prevented the Waſte that is generally made in ſuch a valuable Material, but to proceed.

If any one ſet Fire on a Fell'd Wood he ſhall be puniſhed, and beſides pay three Pound; and for thoſe who cut Wood clandeſtinely (of which the very Sound of the Axe ſhall be a ſufficient Conviction) for every Tree he ſhall be mulcted thirty Shillings.

A Statute made by *Eliz.* to prohibit the Converting of Timber Trees to Coal or Fuel for the Uſe of Iron-Mills, if the Tree was of 12 Inches Square, and growing within 14 Miles of the Sea, or the greater Rivers, but only ſome particular Places in *Kent*, *Suſſex*, and *Surry*, were excepted in the Proviſo, for Reaſons expreſſed in the Statute of 23 *Eliz.* by which even the employing of any Under-wood, as well as great Timber, was prohibited within 22 Miles of *London*,

London, and many other Navigable Rivers, Creeks, and other leſſer Diſtances from ſome Parts, *Suſſex* Downs, Cinque Ports, Havens.

As to the Law of Tythes, I find Timber Trees pay none, but others do, both for Body, Branch, Bark, Fruit, Root, and even the Suckers growing out of them, and the Tenth of the Body ſold or kept, and ſo of Sallows, Willows, and all other Trees not apt for Timber; alſo of *Sylva-cædua*, as Coppice and Underwood, pay the Tenth, whenever the Proprietor receives his nine Parts, except they are cut for Fencing, and the like, within the Pariſh

The Tythe of Maſts of Oak or Beech, if ſold, muſt be anſwer'd by the Tenth Penny, if eaten by Swine, the Worth of it.

The King of *Spain* has, near *Bilboa*, ſixteen Times as many Acres of Copſe Wood as are fit to be cut for Coals in one Year; ſo that when it's ready to be fell'd an Officer firſt marks ſuch as are like to prove Ship Timber.

The Practice in *Germany* and *France* is, that the Lords (and for the Crown Lands the King's Commiſſioners) divide the Woods and Foreſts into eighty Partitions, every Year ſelling one of the Diviſions, ſo as no Wood is fell'd in leſs than Fourſcore Years; and when any one Partition is to be cut down, the Officer, or Lord, contracts with the Buyer that he ſhall, at the Diſtance of every twenty Foot, leave a good, fair, ſound, and fruitful Oak ſtanding; thoſe of 'twixt forty and fifty Years ſtanding they reckon the beſt: But theſe and many other wholeſome Ordinances, eſpecially as they concern the Foreſt of *Dean*, are compriſed in the Statute of the Twentieth of *Car.* the *2d.* and them Laws are worthy our Peruſal; as alſo the Statute preſcribeth a Scheme of Proportions for the ſeveral Scantlings of Building Timber, which you have 19 *Car.* II, intituled, *An Act for the Rebuilding of* London, to which I refer the Reader.

Mr. *Evelyn* ends the Diſcourſe with ſome uſeful Directions of what Care may be taken towards Improving and Planting his Majeſty's Foreſts, recommending all that he ſays to his moſt Sacred Majeſty then Living; and to the Honourable the Parliament; to the principal Officers and Commiſſioners of his Majeſty's Navy; that where ſuch Improvements may be made it be ſpeedily and vigorouſly proſecuted, and where any Defects appear, they may be duly reformed.

He ſeems to hint what Benefit may enſue if proper Perſons were Authorized to inſpect and regulate the Proportion of Timber, *&c.* and where, and how to be planted in every Hundred or number of Acres, as the Honourable the Commiſſioners of the Navy did then ſuggeſt, or as may be thought convenient, the Quality and Nature of the Places prudently conſidered; it ſhould be their Office alſo to take Notice of the Growth and Decay of Woods, and of their Fitneſs for Publick Uſes and Sale; and of all theſe to give Advertiſements, that all Defects in their ill Governing may be ſpeedily remedied, and the Superior Officer, or Surveyor, ſhould be accountable to the Lord High Treaſurer, and to the principal Officers of his Majeſty's Navy for the Time being.

Such Cautions as theſe are really very curious, of the general Care that ſeem'd to be at that Time (when Mr. *Evelyn* writ his *Sylva*) for preſerving the Growth and Increaſe of Timber in *England*, every one ſtriving to outdo another in Promoting this grand Concern, and Advancing the Preſervation of that moſt uſeful and neceſſary Material, and bringing the Application of all Timber Trees into the neareſt Compaſs, and alſo under the moſt Frugal Heads.

I ſhall not burden my Reader any longer in repeating what Mr. *Evelyn* has writ in his *Sylva*, altho' the whole Book is really Compact with ſuch Inſtances that ought to be known by any that nicely deals in the Growth or Aplication of any Sort of Timber Trees; however, I ſhall rather refer ſuch as are willing to make themſelves thoroughly knowing of the Nature of Wood to the Book it ſelf, wherein will be found a Learn'd and Philoſophical Diſcourſe of the Nature of moſt Sorts of Timber Trees, with Directions for the Uſe of the ſame; and really, in my Opinion, that Book is very diverting, and it's alſo to be wiſhed that our young Shipwrights would ſpend that Time (which they ſo fooliſhly waſte on idle Paſtimes) in Reading ſuch Wiſe Diſcourſes, which would really qualify them with that Philoſophical Knowledge in our Affairs that they ought to be endowed with before they write themſelves Maſters of our Myſterious Science.

I ſhall now proceed to ſhew ſomething of the Application of Timber in general, and how it may be applied with the utmoſt Frugality; tho' I have been ſomewhat Particular in my *Ship-Builder's Aſſiſtant* of the Value of Timber according to the Bulk, alſo Plank and Trenels; I have mention'd ſomething of the Nature of Meaſuring, and converting Plank to its various Uſes, and therefore ſhall not in the leaſt manner make Repetitions of what I have ſet forth there; alſo in this Treatiſe I have ſhewn the Nature of converting rough Timber to its various Uſes, and what ought principally to be minded in that Affair, which you will find in that Obſervation. And now I ſhall ſhew another principal Part, and indeed the only Part that remains unrevealed, which is to diſpoſe and apply the Waſte of rough Timber to the greateſt Benefit, which undoubtedly, if minded, will prove very beneficial, not only to the Ship-builders or Owners, but alſo to the Labouring Man, and in that Conſideration I ſhall alſo inſtance ſomething of the Nature of ſuch ſmall Materials as will be producted out of the Shreds, or Chips of Timber.

Which Obſervation I ſhall, with all Submiſſion, direct to the Right Honourable the Lord High Admiral of *Great Britain*, or the Lords Commiſſioners of the Admiralty, the Honourable the Commiſſioners of the Navy, and who elſe it may concern; towards Preſerving and Encouraging the Manufactures of *Great Britain* in Oak and Elm Timber, and ſaving large Sums of Money in the general Expence of Building and Rebuilding Ships, which Propoſition (as I may term it) I ſhall divide into Paragraphs.

Par. the Firſt. That it has been an Ancient Cuſtom, almoſt Time out of Mind, that the Artificers in all Publick Yards (made uſe of in Building and Rebuilding, either the Naval or the Merchants Ships) have carried and diſpoſed of to their own proper Uſe the Waſte, as Chips, eſpecially ſuch as have fairly fell from the Ax or Addice, and have been as abſolutely allowed ſuch a Privilege by the Officers appointed to inſpect and direct the ſame, as their Wages in all Publick Service has been allowed ſuch Artificers by the Laws of the Realm.

Par. 2d. That in Caſe (as it ſeems very probable) there may be employed in the General Pay (of Ship-Carpenters) 2400 Men, and of Calkers, Joyners, Houſe-Carpenters, Sawyers, Riggers, and Labourers, put together ſuch a Number may be ſuppoſed as will amount to 4800 Men.

Par. 3d. That the Weight of one Foot of Oak is near 56 Pound, and Elm 43 Pounds and a Half, and of Fir 40 Pound; ſo that a very moderate Bundle of Chips, that may be carried by the ſmalleſt Prentice, is very likely to be one Foot Square, and by a luſty Ship-Carpenter, at leaſt two Foot; that it may be computed, one Day with another, without nicely allowing a Bundle of Chips to any other Artificer, except the Shipwrights, and ſome other contingent Matters, there may be waſted, one Day with another (to ſuply ſuch a Number of Men) 3000 Foot of Timber.

Par. 4th. That every Foot of Timber, either of Oak, Elm, or Fir, in the Publick Expence, has been at leaſt one Shilling, and the Value of one Foot of Plank, (conſidering of it as a ſolid Foot, or 1728 Inches) is three Shillings; from which it will follow that the 3000 Foot of Chips that are appropriated to the Workman's Uſe, will amount to near 300 Pound, one Day with another.

Par. 5th. You may take Notice that in this Calculation I have not allowed a Chip to any other Artificer except the Ship Carpenter, neither have I advanced extravagant Prices in Plank and Timber; but, by a moderate Computation I preſume that the ſaid Waſte of Plank and Timber in employing ſuch a Number of Men, will amount to, and actually before it was obtain'd coſt the Purchaſers 300 Pound *per Diem*, which will be 1800 Pounds a Week, and 93600 Pounds a Year.

Par. 6th. That the Artificer, provided he could ſpare the Chips from his own Fire (which is very rare to obſerve, except in thoſe that are Single Men, and have no Family to expend it) can generally ſell the ſame for nine and ten Shillings *per* Fathom, which contains 72 Foot, and is not ſeven Farthings *per* Foot; ſo that the greateſt Profit the Artificer makes of his Chips is not above three Pence *per Diem*, or at moſt the ¼ Part of what the Prime Coſt is to the Provider.

Par. 7th. That I have often obſerv'd the Artificer Covetous of embracing 3 Pence *per* Day, and relinquiſh his Intereſt in the Chips, ſo that ¾ of 93600 Pounds, which is 70200 Pounds worth of Timber may be yearly ſaved, and converted to more Material Uſes than the Fire; of which I ſhall endeavour to ſhew as follows.

And firſt I begin with the Wedge which is one of the Mechanick Powers, and very uſeful in Ship-Building, there being a vaſt Quantity of ſuch Materials uſed both in the publick, and alſo in the private Service; they are generally Elm, and at ſome Times converted from principal Timber, that in all Likelihood may ſtand the Purchaſer in 8 *l. per* Load, before it's converted into ſuch a Utenſil.

A Wedge, ſuitable for Ship-work, is generally 4 Inches Square at the Head and 18 Inches long, ſo that 50 Foot of Timber, or one Load, will produce 600 Wedges, provided it be Sound, which is very rare to obſerve in Elm, the intrinſick Defects being ſo very common, and often beyond the Inſpection of a very good Purveyor; ſo that with the Sawing at 3 Shillings *per* Hundred, they will charge the Owner 30 *s. per* Hundred, and above Three pence Halfpenny a Piece.

You are to obſerve that this principal Elm mention'd is ſuch as was converted into Keel Pieces or Plank and Dye Square before it was received, that the Waſte is left with the Proprietor, and ſuch a large Price allowed him for the Diſadvantage he has in diſcovering ſome Defects.

I ſhall ſuppoſe that in employing the Number of Men beforemention'd they may Expend, one Day with another, 3000 Wedges, which at one Penny each (for at this Time I ſhall charge the Value there) is 12 *l.* 10 *s. per* Day, and 75 Pound a Week, which is 3900 a Year.

I will juſt hint of one Sort of Wedges that's uſed in the Buſineſs of Ship-Building, that are only Oaken Limbs, hewed according to the Nature of the Growth, which were they purchaſed for one Penny each, are not really worth half the Money, but are rather a Hinderance, and actually retards the Service inſtead of forwarding the Buſineſs, and helping the Artificer to perform his Labour; as I ſhall more particularly explain hereafter, but firſt proceed to the Trenels.

The Trenels are Materials made uſe of in Building and Rebuilding Ships; their Lengths are various, according to the Uſe from 3 Foot Long to 1 Foot, the Price generally given is various, according to the Advantage of obtaining them: However, in my *Ship-Builder's Aſſiſtant* I have mention'd ſomething that will guide you in Valuing the ſame.

I proceed again to ſtate the Caſe, that there is, in all Likelihood, uſed amongſt ſuch a Number of Shipwrights as 2400, of two Foot, one Foot and a Half, and 1 Foot Trenels (counting a Year round, one Day with another) 4000, which, at 3 *s. per* Hundred is 6 *l.* and is 36 *l.* a Week, and 1872 *l.* a Year, which put to 3900, is 5772 *l.* yearly expended.

Then provided there is Waſte of Timber in the publick Expences of Ship-Building that would make ſuch Materials, as I preſume was never known otherwiſe, ſince the Top-ends of Oaks will be really very uſeful for either Wedge or Trenel, beſides other Waſte of Elm, which is generally conſumed for Fires, would ſerve for the Wedge; then the 3000 Wedges would be provided for 1872 *l.*; ſo that 2028 *l.* would be ſaved in the Wedges every Year, and 4000 Trenels would be made for 40 Shillings, that there would be ſaved yearly in the Trenels 1248 *l.* which put to 2028 *l.* makes 3276 *l.* the Sum that may be moderately ſaved every Year, in employing 2400 Shipwrights, and ſuch another Sum ſaved in the Management of the Work, as I ſhall more particularly prove hereafter.

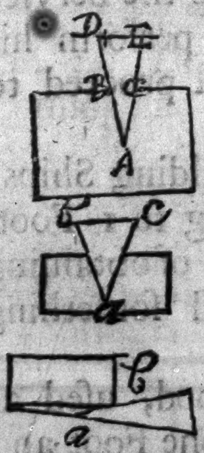
But not to make a perfect Stop here on ſo Material a Caſe, ſince there will be a large Quantity of Waſte made, more than what may be ſpared to make and provide the Wedges and the Trenels in ſuch a grand Expence, which I ſhall deem proper for ſuch Material Fires which cannot well be ſupplyed otherwiſe; as to Heat, and bend ſtraight Planks to the Circular Poſition that is requiſite in Building and Rebuilding Ships, and which, as I ſhall fully prove, will ſave vaſt Expences in providing Bavins to do that Work.

For as it's very probable there may be expended, one Week with another, 6000 Bavins, at 14 *s. per* Hundred, which is 42 *l.* it's apparently manifeſt, that one Fathom of Wood which will be producted from the Waſte, will do as much Service as 200 Bavins, and ſtands the Owner not in ¼ of the Value.

That there is, beſides ſuch Materials mention'd, abundance of others, as Wrain-Staves, Quarters, Need-Wedges, Spiles, Port-Bars, all which may be alſo found and provided on the ſame Foot; and from the Waſte of Timber, which in the General is made out into Chips, as aforeſaid; ſo that if every Artificer that is intituled to carry Chips was allowed 3 *d. per* Day, and did relinquiſh his Chips, the Sum wou'd amount to but ¼ of the Value that purchaſes the Waſte, which is 23400 *l.* and provided it could be proved that Timber could not be nicely converted to Exactneſs in the Woods, and ſerved to its reſpective Uſes, ſo (which I am almoſt poſitive the knowing'ſt Shipwright in *England* would find a hard Task for to prove) then there may be ſuch a Method took in converting it to more material Uſes than the Fire, and ſave, at leaſt, the ⅓ of 93000 *l.* in the Employment of 2400 Shipwrights, which will amount to 31000 *l.* a Year; from which I ſhall endeavour to prove the Unreaſonable of buying hew'd Wedges, when ſuch Waſte lyes to rot, or be burn'd; alſo the Diſability of ſuch Materials to the Service, and in this Treatiſe I ſhall mention the Timber, which will be moſt ſuitable for Wedge or Trenel.

Firſt of the Wedge, which is one of the five Mechanick Powers, the Efficacy and great Strength of it may be reſolved into theſe two Particulars.

1. The Form of it. 2. The Manner whereby the Power is impreſſed upon it, which is by Force of Blows.



Ariſtotle hath Mechanically explained it thus, That each Side *A D*, and *A E*, being on the Points, *B C* are inſtead of ſeveral Props, or Fulciments, the Weight to be moved at *A*, and the Power, or Stroke, with a Hammer that ſhall be applied to move it, being at *D E*; but becauſe this Inſtrument may be uſed that the Point of it ſhall not touch the Body, to be moved as in the other Figures.

Therefore *Vbaldus* has more exactly applied the ſeveral Parts of it according to this Form, That the Point *a* ſhould be as the common Fulciment, in which both the Sides do meet and as it were uphold one another; the Points *b* and *c* repreſent that Part of the Leavers where the Weight is placed.

All Authors agree, that the more acute the Angles of Wedges are, by ſo much more eaſie will their Motion be, the Force being more eaſily impreſſed, and the Space, wherein the Body is moved being ſo much the leſs, and ſuch Conſiderations ought indeed to guide us in providing ſuch Materials.

Firſt, They ought to be made as Sharp as the Conveniency will allow. Secondly, They ought to be made in true Shape, according to the Deſign of the Inſtrument.

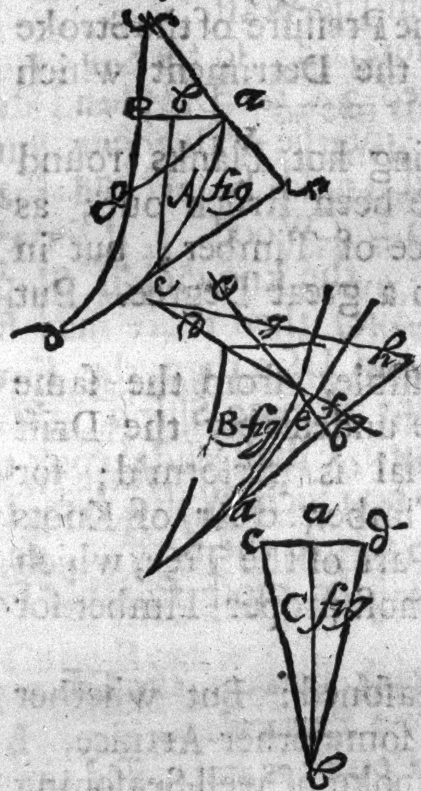
It being very obſervable tht all Mechanick Powers, or complicated Engines,

gines, are compoſed of circular, or perfectly ſtraight Lines, and any other Shape is allowed to be perplexed and irregular, and not fitting for any genuine Deſign.

The Second Particular, whereby this Faculty hath its Force, is the Manner whereby the Power is impreſſed upon it, which is by a Stroke or Blow; the Efficacy of which doth exceed any other Strength.

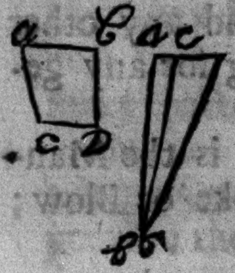
This Percuſſion, or Blow, muſt needs be more effectual, by ſo much nearer it is ſtruck direct, or on the Center of the Wedge, which has been often obſerved in Driving Bolts, that there is a Center, or, what the Shipwrights term the Trim of the Bolt; which is no other than ſtrikeing the Bolt direct, or on that Part that increaſes the Motion moſt with the eaſieſt Blow.

This Conſideration of a Wedge may be applicable to every one of our Edg-Tools, it being very obſerveable what Difference there is in grinding and ſeting the Bezel of the Ax, or any other Tool, and the different Effect there is in the Man's Labour, between a ſharp, regular, well-temper'd Tool, and One that is dull, irregular, and out of Order; which brings me more particularly to ſhew the Inſufficiency of the common hew'd Wedges, that are ſo generally uſed.

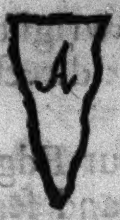


As in Caſe there was a Limb of a Tree, that grew according to the Figure *A* (as was afore obſerved) in the Shape of the Tinge, or *d e e*, the Percuſſion, or Stroke, would be at *b*; but the Moving of the Wedge would be according to the Sides *d f*, *d g*, until it comes to *g*, and then it will be according to the Sides *g a*; which (as you may very plainly ſee) will make the Wedge very obtuſe, to what it may reaſonably be expected to be according to the bare Appearance of the ſame: The Center, or Direction of the Wedge, alſo lyes in the Line *a g*; therefore the Stroke ſhould be at *a*, inſtead of being made at *b*.

That the Head of all Wedges ſhould be cut perpendicular to the Motion of the ſame; as in the Figure *B*. The Wedge deſcribed by the Tinge ought to be ſhaped; firſt, The Head ought to be cut according to the Line *c b*, until the Wedge is drove as far as *a*; and then the Head to be according to the Line *d f*, until the Wedge is drove as far as *e*; and ſo ſucceſſively alter'd according to the perpendicular Line, made from the middle Line *a b*, in the Figure *c*; where you may obſerve, that at every Alteration of the Sides of the Wedge, the Head ought to be cut perpendicular to the middle Line *a b*, That is, *c d* muſt be perfectly ſquare to *a b*; or at right Angles from the Direction of the Wedge; which may in ſome Meaſure ſhew the Defect of Wedges, that are made contrary to two perfect right Angled Triangles, as may be ſeen in Figure C, where the Figure, *a d b*, and *c a b*, are perfectly ſo; and conſequently no other ſhaped Wedges can be uſeful, or convenient for Ship-work; but are really rather Retarding to the Service than any ways aſſiſting or forwarding to the Work: However, I ſhall not in this Place, ſhew every Shape that is uſed of ſuch Materials, nor the particular Unreaſonableneſs in each of them, it being a Matter too tedious for this Work; and therefore univerſally condemn them, and declare them to be uſeleſs. But to proceed a little farther on this Head.



In Caſe (as it's very often obſerved in hew'd Wedges) that the Side of the Wedge *c b*, be thinner than the Side *a b*, the Wedge will be very apt to fly out towards the Side *a b*, and not preſs the other Wedge (if there be any) perpendicular to the Strain, alſo the Motion will be Part ſideways and Part endways, which may be applicable to what Shipwrights term, no Set, or of no regular Force to do Good.



I ſhall inſtance one Caſe more in Figure *A*, that the Sides of the Wedge having Ax-Chops in the Sides, as very often happen in hew'd Wedges, why they, the Bunches, or projecting Parts are Stops, and of Hindrance to the Force impell'd on the Wedge; ſo that the ſaw'd Wedges muſt needs be more efficacious, and more ſecure than the hew'd Wedges, not only in my ſingle Opinion, but by the general Vogue.

Indeed it cannot be deny'd, but that all Timber which is parted by the Saw, is effected by ſuch ſawing farther than what barely appears, the Grain being rais'd, and the Sides of the Timber by ſuch Raiſing, becomes much ſofter than it would be if that outſide Chip was taken away; but ſuch a Faculty will appear beneficial in regularly yeilding to the Preſſure of the Stroke or Blow; which brings me to mention ſomething of the Detriment which may happen in the Uſe, and Defect of ſuch Materials.

For, in Caſe, as it has been often obſerved in forceing hot Planks round ſome Part of the Ship, that ſuch irregular Wedges have been ſtruck out; as has not only endangered the Spoiling of a valuable Piece of Timber; but in all Likelihood damnified the Workman in his Hurry to a great Degree. But Leaving this Subject, I proceed to the Trenels.

The Trenels ought to be made direct, if it be poſſible, from the ſame Conſideration of what has been ſaid of the Wedge, ſince undeniably the Drift will be much eaſier by ſo much the truer the Material is perform'd; for which Reaſon they ought to be made of the ſoundeſt Timber, clear of Knots and Sap, and the ſmoother the better; ſo that the Top Part of the Tree, which is free from Knots, and ſtraight Grain'd, will be the moſt proper Timber for making them.

They ought to be throughly dry, and alſo well ſeaſoned: But whether ſuch Seaſoning conſiſts in long lying after made, or by ſome other Artifice, I have fully mention'd in ſome other Part, where I have ſpoke of well Seaſoning of Timber.

There ought to be a ſpecial Regard had to the Sizeing of the Augre to the Trenel, or the Trenel to the Augre, it matters not which, generally ſpeaking.

In driving Trenels I have obſerved very great Controverſies, and alſo Neglect; which may be, and no Doubt has been, the total Loſs of divers Ships: For, altho' an Overſeer be placed, and a very careful Man too, there may be great Faults committed; as for Inſtance, In driving Trenels through the outſide Plank and Timber, a careleſs Fellow drives ſeveral ſlack; and they not being drove out again, but cover'd with the inſide Plank, may be calked, and carried to Sea in the Ship; which in all Likelihood will increaſe Leakage in the Ship, and not be actually known from whence it proceeds; which may be alſo done for want of Skill, as well as by Neglect, the Workman not knowing directly to ſize his Augre ſuitable to the exact (Mooting of the Trenel) Size or Diameter of it; which if he doth, then the Miſ-doing of it muſt be Neglect, and ought to be puniſh'd. I ſhall endeavour to ſhew how this Caſe may be exactly known, that there may be no Excuſe for committing of it.

I have obſerved, that an Augre of 1 Inch and Half Diameter, has been very ſuitable to drive a Trenel of 1 Inch and ¾ Diameter, which is call'd a Broad-

Arrow, and the Character is thus ↑, and the Method I ſhall proceed in, to ſize all the other, is as follows:

Characters.	Inch.	Pts.	The Diameter of the Trenel, in Inches and Sixteen Parts. In.	Pts.
Round ⊙ and Spot ——	2	0	1	$\frac{23}{32}$ or 1 Inch $\frac{5}{8}$ and $\frac{3}{32}$ Parts of an Inch.
Round ○ —— ——	1	$\frac{15}{16}$	1	$\frac{21}{32}$ and $\frac{4}{10}$ of 32 Pts. or 1 Inch $\frac{5}{8}$ and $\frac{1}{32}$ and $\frac{4}{10}$ of 32 Pts.
Double Hook Z ——	1	$\frac{7}{8}$	1	$\frac{19}{32}$ and $\frac{4}{10}$, or 1 Inch $\frac{1}{2}$ and $\frac{3}{32}$ and $\frac{4}{10}$ of the 32 Parts.
Broad Arrow ↑ ——	1	$\frac{3}{4}$	1	$\frac{15}{32}$ and $\frac{13}{20}$, or 1 Inch $\frac{1}{2}$ except $\frac{3}{15}$.
Croſs + —— ——	1	$\frac{5}{8}$	1	$\frac{12}{32}$ and $\frac{13}{20}$, or 1 Inch $\frac{3}{8}$ and $\frac{20}{30}$ Pts. of the 32 Parts.
Headleſs Croſs T ——	1	$\frac{1}{2}$	1	$\frac{9}{32}$ and $\frac{7}{20}$, or 1 Inch $\frac{1}{4}$ and $\frac{1}{32}$ Part.
A Five V —— ——	1	$\frac{3}{8}$	1	$\frac{6}{32}$ or —— 1 Inch $\frac{3}{16}$ of an Inch.
A Four IIII —— ——	1	$\frac{1}{4}$	1	$\frac{2}{32}$ and $\frac{3}{4}$ of the $\frac{1}{32}$ Parts.
A Three III —— ——	1	$\frac{1}{8}$	0	$\frac{31}{32}$ and $\frac{3}{10}$ Parts of the $\frac{1}{32}$ Parts.

But for a clearer Illuſtration, I ſhall ſet down the Size of the Augre, to ſuit the Dimenſions of our Common Rules, as follows:

In.	Pts.
1	$\frac{11}{16}$ and $\frac{1}{2}$
1	$\frac{10}{16}$ and $\frac{7}{10}$
1	$\frac{9}{16}$ and $\frac{7}{10}$
1	$\frac{7}{16}$ and $\frac{85}{100}$
1	$\frac{6}{16}$ and $\frac{12}{100}$
1	$\frac{4}{16}$ and $\frac{65}{100}$
1	$\frac{3}{16}$
1	$\frac{1}{16}$ and $\frac{17}{100}$
0	$\frac{15}{16}$ and $\frac{65}{100}$

of a $\frac{1}{16}$ Part

You may obſerve, that the Exceſs in the firſt Size, between Trenel and Augre, is $\frac{4}{16}$ Parts $\frac{1}{2}$ of a $\frac{1}{16}$ Part, or $\frac{1}{4}$ of an Inch, and the $\frac{1}{32}$ Parts of an Inch, the Exceſs in the laſt Size is between the Trenel and Augre is $\frac{2}{16}$ of an Inch, and $\frac{35}{100}$ or $\frac{1}{8}$ of an Inch, and $\frac{35}{100}$ Parts of $\frac{1}{16}$ of an Inch.

Notwithſtanding, ſince this Faculty in Ship-Building is ſo very material, I therefore recommend it to be thoroughly known, and brought to an exact Fit; I ſhall therefore ſhew in what Method I proceeded to Calculate the preceeding Tables, and obtain ſuch Proportions.

Firſt, I divide the Inch into 32 Parts, then ſay as the Cube-Root of the Circumference, is to the Cube-Root of the Exceſs in one Augre, or the 1 Inch and $\frac{1}{2}$ ↑ Augre, which I take for my Standard; ſo is the Cube-Root of the other Augres Circumference to the Cube-Root of the Exceſs in the ſame.

An Inch and $\frac{1}{2}$ Augre has 48 Parts; then as 7 to 22, ſo is 48 to 150 $\frac{1}{2}$ the Cube-Root is 5 $\frac{4}{10}$.

Exceſs is $\frac{1}{4}$ of an Inch, which is $\frac{8}{32}$ Parts, the Circumference is 25 $\frac{1}{10}$ the Cube-Root is 2 $\frac{19}{20}$.

An Augre of 1 Inch $\frac{3}{8}$ diameter hath 44 Parts, the Circumference is 138 Cube-Root is 5 $\frac{2}{19}$.

Exceſs Cube-Root Circumference is 2 $\frac{17}{20}$, the Circumference is 22 $\frac{3}{4}$, and Diameter 7 $\frac{1}{4}$, Exceſs or Difference is $\frac{7}{32}$ and $\frac{7}{10}$ of $\frac{1}{32}$.

An Augre of 1 Inch $\frac{3}{4}$ has 56 Parts, the Circumference is 176, Cube-Root is 5 $\frac{6}{10}$, the proportional Number to find the Exceſs 3 $\frac{1}{20}$. Circumference of which is 28 $\frac{1}{4}$, and Diameter is 9. Exceſs or Difference between the Trenel and the Augre is $\frac{8}{32}$ and $\frac{3}{10}$ of $\frac{1}{32}$.

An Augre of 1 Inch $\frac{11}{16}$ has 54 Parts, the Circumference is 169 $\frac{2}{10}$, Cube-Root of which is 5 $\frac{11}{20}$. The proportional Number to find the Exceſs is 3. Circumference of which is 27. Diameter is 8 $\frac{6}{10}$.

An Augre of 1 Inch $\frac{5}{8}$ has 52 Parts, the Circumference is 163, Cube-Root of which is 5 $\frac{5}{10}$. The proportional Number to find the Exceſs is 2 $\frac{28}{100}$, Circumference of which is 26 $\frac{9}{10}$, Diameter is 8 $\frac{4}{10}$.

An Augre of 1 Inch $\frac{1}{2}$ has 48 Parts, the Circumference is 150 $\frac{1}{2}$, Cube-Root of which is 5 $\frac{4}{10}$. The proportional Number to find the Exceſs is 2 $\frac{24}{100}$, Circumference of which is 25 $\frac{5}{10}$, Diameter is 8 $\frac{1}{20}$.

An Augre of 1 Inch $\frac{3}{8}$ has 44 Parts, the Circumference is 138, Cube-Root of which is 5 $\frac{2}{10}$. The proportional Part to find the Exceſs is 2 $\frac{17}{20}$, Circumference of which is 23, Diameter is 7 $\frac{7}{20}$.

An Augre of 1 Inch $\frac{1}{4}$ has 40 Parts, the Circumference is 125, Cube Root of which is 5. The proportional Number to find the Exceſs is $2\frac{15}{20}$, Circumference of which is 21, Diameter is $6\frac{7}{10}$.

An Augre of 1 Inch $\frac{1}{8}$ has 36 Parts, the Circumſerence of which is 113. Cube-Root of which is $4\frac{17}{20}$. The proportional Number to find the Exceſs is $2\frac{13}{20}$, Circumference of which is $18\frac{8}{10}$, Diameter is 6.

An Augre of 1 Inch Diameter has 32 Parts, the Circumference of which is $100\frac{5}{100}$, Cube-Root of which is $4\frac{13}{20}$. The proportional Number to find the Exceſs is $2\frac{11}{20}$, Circumference of which is $16\frac{5}{10}$, Diameter is $5\frac{1}{20}$.

An Augre of $\frac{7}{8}$ of an Inch has 28 Parts, the Circumſerence of which is $90\frac{8}{10}$. Cube-Root of which is $4\frac{5}{10}$. The proportional Number to find the Exceſs is $2\frac{9}{20}$, Circumference of which is $14\frac{8}{10}$, Diameter is $4\frac{7}{10}$.

You may further obſerve in this Calculation, that having divided every Inch or Parts of an Inch the Augre is in Diameter into 32 Parts, I find the Circumference of them Parts, and the Cube-Root of that Circumference, then I take the Exceſs of the 1 Inch and $\frac{1}{2}$ Augre (that I take to be a good Standard) which being $\frac{1}{4}$ of an Inch, or 8 Parts, I find the Circumference of that Exceſs, and alſo the Cube-Root of it: Then (as aforeſaid) I ſay, as the Cube-Root of the Circumference in one Augre is to the Cube-Root of the Circumference in the other Augre; ſo is the Cube-Root of the Exceſs in one Augre, to the Cube-Root of the Exceſs in the other Augre; then adding that Exceſs found to the Diameter of the Augre, it gives me the Diameter of my Trenel, which was to be demonſtrated.

It's plain, that the common Difference or Exceſs, between the Trenel and the Augre, is $\frac{1}{4}$ of an Inch; and ſo increaſing and decreaſing, according as the Diameter of the Augre alters its Bigneſs; but the Difference between the Bolt and the Augre is but $\frac{1}{8}$ of an Inch in ſome Sizes; from which it will appear, that the Bolt being made of Iron, yields not to the Preſſure that is cauſed in the Entering the Hole, but forces the Wood to yield all; alſo that the Wood which is raiſ'd by the Augre's Cutting, is made ſofter and more pliable, as I mention'd about Sawing; and therefore the Hole and Pin yields almoſt in an equal Degree.

Notwithſtanding there is a vaſt Difference between the Weight of Iron-Bolts and Wooden-Pins; which different Weight in the Bolt more than in the Trenel, is Reſiſtance; and ſuch Difference ought to be advanced by Force, or Percuſſion of the Hammer, either in a greater Number of Hammers, or by a greater Weight of one ſingle Hammer, and Strength apply'd in the Swing; but the Number of Hammers in all Likelihood, will cauſe the Continuance of Motion beſt, and probably advance the Weight ſwifteſt; which Faculty ought alſo to be conſidered in driving Trenels, that the Length of the Trenel, and the Bigneſs, will require more Artifice to force than thoſe that are ſhorter and leſs.

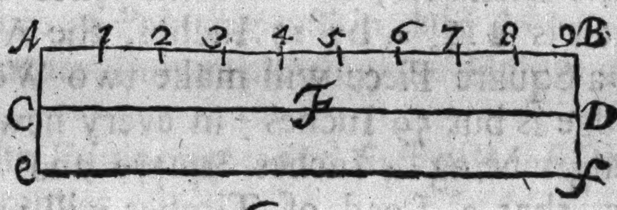
There is beſides, another Difference between a Bolt and a Trenel in advancing them into Holes for Ship-work, ſince the Iron is harder than Wood, it will clear the Hole better by cutting of the Hinderance; but Wood cannot cut Wood of the ſame Species; and therefore the Point of a Trenel that enters, ought to be ſomething Biger than the middle Part, which is often done in taking off a ſmall Chip in the Middle of the Trenel, eſpecially if it be above 18 Inches long.

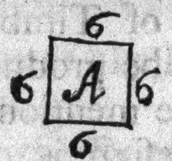
Trenels are generally made of the beſt Oak; which Wood (in the general Opinion) is as proper for the Uſe as any other Wood whatever: However, the Wood that ſuch Pins are drove into is not always Oak, but of divers Sorts; as Elm, Aſh, Fir, and the like: And in ſuch a Caſe there ought to be a Difference in the Exceſs between the Trenel and the Augre, provided the Pin be wholly drove into ſuch light Timber; which Difference to adjuſt, will be very near according as the Weight of one Wood is to the Weight of the other, ſince it is the Texture and Hardneſs of the Wood, that will cauſe the Difference in the Drift, or driving of any Trenel.

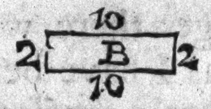
And that Difference may be more particularly made up or adjuſted in the Trenel, thus: Compute the Weight of that Column which is contained in the Hole the Pin is drove into, and that Weight to be added extraordinary into the Weight or Bigneſs of the Trenel, which will cauſe the Trenel to go agreeably ſtiffer in Elm or Fir, or any other Wood that is lighter than Oak, according to the Weight contained in the different Species. I proceed now to conſider of the Material that is produced from the Under-Wood, as Faggots and Bavins, *&c.*

Maſter *Evelyn* ſays, that a Wood Faggot ſhould be made after ſuch a manner, that every Stick in the Faggot ſhould be 3 Foot long, except one Stick of one Foot to harden and wedge the other; and this, ſays he, I mention to prevent an Impoſition that may be in having all the middle part of the Faggot ſhort Rubbiſh.

That the Circumference ſhall be 24 Inches perfectly round, ſince there may be vaſt difference in the Content of a Faggot, and yet be 24 Inches about; which puts me in mind of what I once heard by a Scholar and a Shepherd; the Shepherd (as its very probable) having ask'd the Scholar ſeveral frivolous Queſtions, at length the Scholar deſires the Shepherd to anſwer him one as follows.







In caſe, ſays the Scholar, I have 40 Sheep to pen, and I have 20 Hurdles to make that Pen, how many Hurdles will be requiſite to Pen up 80 Sheep. The Shepherd preſently anſwers 40 Hurdles; but the Scholar made it out that 22 Hurdles ſhould encompaſs 80 Sheep, if 20 would hold 40 Sheep, as in the Figure *F*. Let the Line *A B* contain 9 Hurdles, and alſo *C D* 9 Hurdles more; then from *B* to *D*, and from *A* to *C* is 1 Hurdle each, which makes out the 20 Hurdles propoſed to hold 40 Sheep: Then if this Pen was to be enlarged to hold 40 Sheep more, it's but only taking the Hurdle at *C D*, and carry it to *e f*, and to have two Hurdles more from *D f* and *C e*, and then the Place will contain juſt as much more, and have but an Addition of the $\frac{1}{10}$ of the Hurdles, which before held but $\frac{1}{2}$ of the Number of Sheep.

Again, in the Figures *A* and *B*. Let the Figure *A* be ſuppoſed to be a right Square of 6 Inches every way, and the Figure *B* a long Square, whoſe Length is 10 Inches, and Breadth 2 Inches, which together is 24 Inches equal to the four Sides of the Figure *A*; then × *6* by *6* it's 36, the ſuperficial Content of the Figure *A*; and multiplying 10 by 2 it's 20, the ſuperficial Content of the Figure *B*, that the Proportion of the Superfices is as 9 to 5, and by conſequence the Figure *B* will hold but $\frac{5}{9}$ of the Figure *A*, altho' the Boundings are directly equal.

I ſhall imagine that the Binding of two Faggots be every ways equal to the Figures *A* and *B*, tho' Circular, and to be according to the aſſigned Length of 36 Inches; then × *36* by *36*, it's 1296; then × *36* by 20 it's 720. So that you would have in the Oblong ſhaped Faggot but near $\frac{1}{2}$ of what is in the truly Circular ſhaped Faggot, altho' the Bindings are directly as much in one as in the other, and therefore the Shape of ſuch Goods ought to be as well minded as the exact Proportion; which brings me to conſider in the next Place of Bavins, of which there are divers Sorts; but three Sorts being more immediately uſed on Ship-work, as Broom, Furz, and Bruſh, I ſhall only ſpeak of them.

The firſt two are uſed to breem Ships in order to dreſs them, and the latter for heating of Planks to make them bend.

The general Dimenſions of Broom Bavins is 38 Inches long, and 38 Inches girt, Price is 5 *s. per* Hundred. Dimenſions of Furz Faggots is 44 Inches long, and 44 Inches girt, Price is 7 *s* 6 *d. per* Hundred.

Broom Bavins Circumference is 38 Inches, Diameter $12\frac{1}{10}$, Area is $144\frac{19}{20}$ × by 38, its $4339\frac{2}{10}$.

Furz Bavins Circumference is 44 Inches, Diameter 14, Area 154 × by 44, it's *6776*.

That the Price is near equal to the Content in Inches; but Broom is more preferable than Furz for the Uſe, and therefore more valuable in Proportion of their Inches, provided the Shape (as I have already hinted) be equal to the Bulk.

The Dimenſions of the Bruſh Bavins is 3 Foot long and 24 Inches Circumference. The Price has been 3 *s.* 6 *d. per* Hundred; but I preſume Bruſh is much dearer now: However all ſuch Prices and Dimenſions may vary, and be agreed on between Buyer and Seller at Bargaining; notwithſtanding if I buy any Commodity that the Dimenſions have an aſſigned Standard, I may oblige my Vender to ſerve me with the full Content and Quantity of Goods, according to ſuch a Standard, provided there be no private Agreement to the contrary. In the next Place I ſhall make an Obſervation concerning the Limbs or Lopings of Timber-Trees, and ſhew how advantagious this has been to ſome Timber Broagers.

Firſt then, provided that the hew'd Wedges (as I have afore mention'd) be ſold for a Halfpenny each, it is 4 *s.* 2 *d. per* Hundred, it's manifeſt that a Load or 50 Foot of ſuch Limbs will produce 1450 Wedges, which will then be Three Pounds Five Pence. Since they are generally round, and but 3 Inches Diameter, the Circumference is $9\frac{1}{2}$, Area is 7 Inches, ſquare Root of which is $2\frac{65}{100}$ × by 17 Inches, the Area is 119 Inches as a perfect Square; but a Square Piece will make two Wedges, and therefore the Inches in each Wedge is but 59 Inches $\frac{1}{2}$ in every hew'd Wedge of ſuch a bigneſs; the ſaw'd Wedges being 4 Inches Square and 18 Inches long, the Content is 144 Inches, that a Load of Timber will produce 600 Wedges, but of the hew'd Wedges there will be produced of every Load or 50 Foot, 1450 Wedges, and as I have before mention'd in a manner uſeleſs for ſuch a Service; however, my preſent deſign is only to make obvious that the Lop and Bark is in ſuch a caſe ſold for as much *per* Load as the biggeſt part of the Tree, ſince the produce of the ſuperficial Bark on the Limbs is conſiderably more than the ſuperficial Content of the Bark, on the biggeſt part of any Tree; as for Inſtance, if there was a Tree of two Foot Diameter in the Body, or Bowl, then the Bark in 1 Foot Length would be 7 Foot on the Superficies; but in the Limbs the ſuperficial Content will be much more in Proportion to the ſolid Content of the Timber, ſince a Foot length in the Body of the Tree contains 3 Foot 134 Inches, and produces not quite 7 Foot of Bark; but a Limb of 3 Inches Diameter will produce $\frac{4}{5}$ of one Foot of Bark, and there is but 85 Cubick Inches contained in ſuch a part, whereof 20 of them will go to make one Foot of Timber, or 1728 Inches: So that in every Cubick Foot that is contain'd in ſuch Limbs, there will be 16 ſuperficial Foot of Bark, and in 3 Foot 134 Inches there will be 49 Foot $\frac{1}{4}$ of Bark; ſo that the Proportion of Bark between ſuch Limbs and the Bodies of each reſpective Tree, is near as 7 to 1, which may be ſufficient to prove, that if the Owners of Timber could have ſuch a Vent for their Limbs as to Hew them into Wedges of the aforeſaid Dimenſions, and ſell them for a Halfpenny each, then their Advantage would be much greater in the Loping than in Selling the Body of the Tree. But I'll proceed a little farther on this Head: A Fathom of Wood being 6 Foot long, 6 Foot high, and 2 Foot deep, containing 72 Foot, as its made up in the Shape of what is called Fathom-Wood; which ſaid Quantity is at ſometimes ſold for 10 *s.* and at other times for 12 *s.* and ſo as a Market may advance to 16 *s.* according to the Seaſon and Advantage of obtaining it. I am pretty poſitive, that the 72 Foot of Fathom Wood well managed, will make 1450 Wedges, according to the Faſhion of the hew'd Materials; and allowing 14 *s. per* Hundred for the Wood, there will be 46 *s.* 5 *d.* for making, which will be 3 *s.* 4 *d. per* Hundred, and in all likelyhood a Man a Man may make as many hew'd Wedges as he can of Trenels, and much more in a Day, according to the Smoothneſs and Niceneſs as may be obſerved in making them, beſides the Advantage of the Wood that is chipped off in making ſuch Limbs into Wedges, which will countervail near $\frac{1}{3}$ of a Fathom of Wood, and that will be 4 *s.* 8 *d.* to be put to 46 *s.* 5 *d*, and then the Value of making will be 2 *l.* 11 *s.* 1 *d.*

And having gone through what may neceſſarily occur, in making (as I may in ſome meaſure term it) Timber-Trees for the Uſe of Ship-building, and how they ſhould be applied with the greateſt] Advantage to the Owner, as well as to the Labouring Man, in adapting and fitting Things as near as poſſible to the Uſe, for his diſpatching and putting his Work out of Hand with the greateſt Dexterity; I proceed in the next Place to more particularly ſet forth the Nature of each Artificer's Branch, not only from the Ancient Cuſtoms, but alſo ſhall reduce ſuch Cuſtoms to general Dimenſions, and in doing of it I ſhall proceed in the following Method.

Firſt, I ſhall Inſtance the Nature of Sawing, or dividing of Timber from large Pieces to thoſe of a leſs Denomination; ſince this Part ought to come in firſt, from ſuch Reaſons as I ſhall Inſtance in the ſaid Obſervation.

In the next Place I ſhall conſider the Nature of the Smith's Contract, ſince that is a Material which is joyntly uſed with the Timber, and what any Ship cannot be well put together without.

In the third Place I ſhall conſider the Nature of Calking a Ship, and covering her with Pitch or ſome other Ingredients.

In the fourth Conſideration is the Nature of Painting a Ship, laid down and adjuſted; and ſo are the Material Branches in compleating the Hull of any Ship finiſhed.

In the fifth Conſideration I mention the Equipping; and firſt of Maſts, and all ſort of Fir Timber, either whole or converted.

In the ſixth Conſideration I ſet forth the Nature of the Block-maker's Contract, and how to adjuſt that Part of the Equipping.

In the ſeventh Conſideration is the Nature of the Rope-maker's Contract ſet forth, and how to adjuſt that Part of the Equipping with Advantage to the Owner.

In the eighth Conſideration is the Nature of the Sail-maker's Contract ſet forth, and how to adjuſt that Part of the Equipping, as aforeſaid.

I have alſo in ſeveral Places of the accuſtomary Contracts made Remarks, and ſeveral neceſſary Cautions, for the Diſtinguiſhment of which I have made an N for New.

Of the Sawyers Contract.

SAwing is converting, dividing, or breaking large Pieces of Timber into divers Pieces of a leſſer Denomination; which, without the Help of ſuch an Inſtrument (as is termed a Saw) muſt be chipp'd with an Axe, and reduced from a large Tree (which at ſometimes is divided to 2, 3 or 4 Pieces) into one Piece no ways better for Uſe, than one of thoſe that makes a larger Number, and of Courſe all the Waſte that's produced by chipping is uſeleſs, except for the Fire.

There be diverſe ſorts of Saws, as the Whip-Saw, the Two-hand-Saw, or Croſs-cut-Saw; the Hand-Saw, and alſo ſeveral of a leſſer Denomination; which, altho' they are all very uſeful in their Kind, I ſhall only at preſent ſpeak of the Whip-Saw, which being moſt material of all others, I ſhall conſider of it in ſome Meaſure, both as to the Nature and alſo to the Uſe.

The Whip-Saw may properly import the Long-Saw, to divide large Timber Vertically, and may in ſome Meaſure be reduced to the Leaver, where the Power is communicated by the Strength of Two Men, one ſtanding upon the Timber, and the other under it; and it's really very admirable to ſee how Two Men ſhould ſo nicely and exactly ſtrike their Stroke, and at the ſame time not ſee one another; which may ſeemingly convince us, that there is nothing too hard for Practice, and a continual Uſe of Things.

The Weight is the Timber to be divided (or the Carf) which is more or leſs, according to the Hardneſs of the Timber, and Depth of the ſame.

The Fulciment or Prop muſt be the Teeth of the Saw, which by the ſharpneſs and well temper of the Metal the more the Power is increaſed, and the Timber much eaſier divided, than if the Inſtrument was of another Species, Dull, or of an unproper Mixture.

Notwithſtanding this Inſtrument cannot be properly and abſolutely reduced to the Leaver, but rather to a mixt Machine, conſiſting of Wheel and Leaver, as may be obſerved in the Saw-Mills in the *Eaſtern* Countries; and Mr *Evelyn* in *Sylva* has prettily deſcanted upon it, and ſhews you a Figure wherein are three Saws to be work'd by either Wind or Water, where the riſing and falling of the Saws is performed by the help of either Wheel, Crank, or Swivel.

However, ſuch Engines deſcribed in *Sylva* can be uſeful only for ſtreight Carfs, as for cutting Deals, Plank, and the like, and therefore there muſt be ſome other Conſiderations how to apply it in cutting the Ribs, or crooked Parts of a Ship, notwithſtanding your Mathematical Ingineers will allow, that ſuch Engines may be made uſeful for cutting any crooked Part of a Ship, altho' the moſt difficult; which ſeems not very unlikely, altho' the Body of any Ship is ſo very various in the Shape; but to the Engine I ſhall wave at preſent, and proceed to conſider and apply Sawing. The different Value according to the Magnitude of the Ship; alſo the Reaſonableneſs of what may and what may not be ſawed; but firſt I ſhall conſider the Reaſonableneſs of what may be ſawed, and what had better be converted after another manner.

The uſual Price given for Oak *per* Hundred Foot on the Superficies has been 3 *s.* and the ſame Price has been as well given for Fir and Elm, and had ſo continued, had not the Men of the ſame Practice undertook one another, endeavouring to engroſs it into ſome particular Hands, and ſo the Sawing of Elm and Fir Timber is brought to 2 *s.* 6 *d.* *per* Hundred Foot, and is ſo continued, which altho' is not exactly priced yet; for as I have mention'd in ſome other Places, the difficulty in working Timber muſt be allowed to be from the Hardneſs and Rudeneſs of the Species; ſo that the Proportion will come neareſt to the Weight of each particular Timber: Which is as follows.

Oak to Elm is in Weight as	13 to 9
Oak to Fir is as ———	8 to 5
Oak to Beech is as ———	95 to 93
Oak to Aſh is as ———	21 to 20

	s. *d.*
The Price of Oak is *per* Hundred	3—0
Elm from the Proportion of the Weight is	2—1
Fir from the ſame will be ———	1—10
Beech from the ſame is ———	2—11½
Aſh from the ſame is ———	2—16½

However, there will ſome difference happen in the Dryneſs of the Timber, and the over Greenneſs choaking the Saw's Teeth; but from Practice it's found, that all ſuch Impediments are ſolved between the Inſtrument-maker and Inſtrument-uſer, ſince the Sawyer knows as well what Saw is moſt proper for Oak, Elm or Fir, as any Perſon knows when his Coat or his Shoe fits him, and therefore the Difference in dividing Timber will principally be cauſed by the Hardneſs and Texture of the ſame, which will be better known by the Weight than by any other way, provided the Weight is a like Natural, and not cauſed by Artificial Means.

In the Merchant's Service they generally agree with the Sawyer, to ſaw all that they judge proper to be ſawn, the Sawyer being allow'd a certain Price, according to the Tunnage of the Ship, and indeed ſome Ship-Builders will nicely convert their Timber, that nothing ſhall be waſted but what the Saw (as it may be termed) eats with the Teeth, which may be moſt properly called good Converſion; but indeed Men's Notions differ mightily on this Particular of Converting Timber to the beſt Advantage, and when all their Notions are ſummed together, and again equally divided, the Reſult muſt be, that whatever Timber is Chalked out, or Lined, as it's Term'd, and any Piece of the ſame which is to come off, will be but one Half-penny of more Value than what the Sawing will come to, it will be one Half penny Advance to the Owner, beſides the Time which is expended in Hewing the ſame, which ought to be put into the Price of the Slab, and Counter-ballance the Price of the Sawing.

Beſides, all Timber is valuable according to the Bulk or Bigneſs of the Piece, as I have fully deſcribed in my *Ship-Builder's Aſſiſtant*, which Matter, well and nicely conſidered, any Man needs no other Guide to inſtruct him how to make good Converſions of Timber for any Work.

But however, there is one ill Conveniency in making ſo much uſe of Sawing, and not, in ſome Meaſure, forwarding the Practice of our Youthful Shipwrights in Hewing, which being a Material Branch of Ship-Building, I ſhall endeavour to ſhew it a little clearer, how far it may be reaſonable to mitigate the Practice between the Saw and the Ax.

Firſt then, I would have no Sawyer be ſuffered to ſaw without he can make his Converſion as nice as a Shipwright can with an Addice, which I have ſeen ſome Sawyers able to do; for ſince the Strength of Materials chiefly conſiſts in the even and fine Drawing of it, then all ſaw'd Work, which is not as exactly wrought as Work that is done with an Addice, ought to be trimm'd over again with ſuch an Inſtrument.

Now ſuppoſing that here is a ſmall Piece of Timber, that will make a Beam, or a Wale Piece, or any other ſmall Piece that will be juſt producted out of one rough Tree, ſet the Caſe that the Piece is to be wrought one Foot deep, and 8 Inches thick, and being 50 Foot long, it may contain of Sawyers Work 200 Foot, which at 3 Shillings *per* Hundred, is 6 Shillings; and if the Sawyer is deficient in his Performance, there will not be above one Day's Work of a Man Difference between wholly Hewing the Piece, or Trimming him over again with an Addice after it is ſawed.

But there will be a good handſome Parcel of Cruſt, or outſide of the Piece, which will indeed, if rightly applied, over-ballance what is farther expended in trimmiug the Piece with an Addice.

Notwithſtanding there is one Sort of Converſion very unreaſonable, and that is in Cutting thick Stuff, as Clamps, and ſuch round Pieces that are wrought in Places that wind, and are not upon direct Plains; and it would be much properer for all ſuch Pieces, if they had only a Middle Cut, letting the Shipwright have Wood to work on, to wind him, and give the Piece his true and ſufficient Twiſt that is cauſed by the different Angle or Levelling, in ſhortening the Radius's in the Foremoſt and Aftermoſt Parts of the Ship; and whoever nicely conſiders it, will find the Charge of Firing and Workman's Labour requiſite to burn and bend ſuch Materials (that has not Wood left to wind it) conſiderably to over-top the Charge or Value of ſuch round Pieces, that naturally are cut to the Winding, beſides the Work is not any ways ſo good, nor ſo ſtrong, that is forced as others that grows to the Work.

But to proceed to ſhew the Value of Sawing; and firſt I ſhall ſet down the common Allowance in the Publick Yards, and after ſhall particularly explain the Meaning of it,

			s.	d.	f.
For Cutting every Hundred Foot on the Superficies of Plain Meaſure of the ſeveral Species of	Oak,	The Sawyer is allowed for his Labour.	3	0	
	Elm,		2	6	
	Beach,		3	6	
	Aſh,		3	6	
	Fir,		2	6	

From 5 Inches deep and downwards, the Sawyer is allowed Carſe and ½, which is for every 100 Foot 150 Foot; but this Allowance is alſo taken off by the ſame Means as the Elm and Fir was, and they are allowed but 100 Foot for 100.

Carſes from 5 Inches Deep to 18 Inches Deep, the Allowance is 100 for 100.

Carſes from 18 Inches to 24 Inches Deep, the Allowance is Carſe and ⅓, or 133⅓ for 100.

Carſes from 24 Inches to 36 Inches Deep, two Carſes for one, or 200 for 100.

For Carſes 36 Deep and upwards, the Allowance is 3 *d.* for every ſuperficial Foot that is cut.

Any Timber cut Cant-wiſe, the Allowance is Carſe and ½, or for every 100 Foot 150 Foot.

Anchor Stocks cut the Taper ways, are meaſured 30 Inches from the Middle.

Knees broke or ſided, are to be meaſured in the Middle of the longeſt Carſe.

Rounding Carſes, from 3 Inches Rounding to 5 Inches in 12 Foot long, and under 18 Inches deep, the Allowance is 2 Carſes for one, or for every 50 Foot 100 Foot. If it windes it's to be the ſame Rate or Value cutting.

If the Carſe rounds above 5 Inches in 12 Foot length, and above 18 Inches deep, the Allowance is, for every 44 Foot 100 Foot.

Strings for Stairs, 4 for 1, or for every 25 Foot that's cut, the Allowance is 100 Foot.

80 Wedges cut out of Timber 18 Inches long, and 4 Inches ſquare at the Head, is to be accounted 100 Foot of Work, or 3 *s.* But Wedges of the ſame Size cut out of Plank, 100 of them is to be accounted 100 Foot of Wokr, or 3*s.*

11 Slit-Deals, cut from ordinary Deals, is allowed as 100 Foot of Work, and the whole Deals ſlit into Battons ſhall be deem'd one Deal.

	s.	d.	f.
The Price of Whetting a Whip-ſaw, is —— ——	1		
For Whetting a Croſs-cut Saw. —— ——		2	
For new Cutting and Toothing a Croſs-cut Saw. —— ——	4	6	

Croſs Cuts in Timber to be as follows.

Timber of	Inches Square is to be allowed	Foot of Work.
36	——	25
28	——	14
22	——	11
17	——	8
Under — 17	——	5

Croſs Cuts in Plank to be as follows.

Plank of	Thick, and 16 Inches Broad.	Foot of Work is the Allowance.
4		4
3		3
2		2

	s.	d.	f.
Sawyers that work by the Hundred if they chance to be ordered to work on occaſion a Plain Day's Work, their Allowance is *per* Day —— —— —— —— ——	3	9	

		s.	d.
For one Hour 12 Foot and ½, or ——— ———	0	0	4½
For one Tide 28 Foot, or ——— ——— ———	0	1	1¼
Sawyers that Work continually for the Boat-Builders, are allowed *per* Day, ——— ——— ——— ——— ———	0	3	0
For one Hour, ——— ——— ——— ———	0	0	3½
For one Tide, 30 Foot of Work, or ——— ———	0	0	1

Memorandum, That in Meaſuring the Sawyer's Work you are not to meaſure every Superficies that the Saw rubs againſt, as to explain it thus; That in caſe a four Inch Plank of 20 Foot long, and 12 Inches broad, was to have one Cut, then that Cut from one End to the other is 20 Foot, and ſo it's allowed to the Sawyer: Notwithſtanding the Saw rubbing of each Side the Cut, there is a Superficies of 40 Foot cut, and what a Perſon that is not acquainted may be made believe; however the Cuſtom is otherwiſe in all Meaſurement of the Sawyers Contract.

The Allowances are what is generally in the Publick Yards, where, in all likelihood, they have been well obſerved and nicely Conn'd over by a Number of Officers which are appointed to inſpect the Particulars. However, I ſhall endeavour to explain thoſe Heads in Courſe, and ſhew what general Proportions may be made from them; and having already ſhewn how the different Value of Timber (as to the Sawing) ought to be allowed from the Weight of the Species and Texture of the Wood, I proceed to ſhew how far it is reaſonable for the Allowance to be made for what is termed Carſe and Half, and the like.

Firſt, It is ſaid that in all ſtraight Carſes, from five Inches deep and downwards there ſhall be allowed to the Sawyer Carſe and half, or 67 Foot cut ſhall be deem'd 100 Foot in Meaſure; now one Foot on a Superficies is 144 Inches, ſo that in the Allowance the Sawyer is to cut but 96 Inches for 144 Inches, and for every 100 Foot he cuts he is to be allowed 150 Foot, which is the plain Meaning of Carſe and half, and for every 8 Inches 12.

Now to the Reaſonableneſs of the ſame, I cannot abſolutely ſay Why, or Wherefore it was allowed; but, according to the Notion I have in Buſineſs, it muſt be meant of the Intervals, which may happen in bringing ſuch piddling Work to a ſuitable Poſition for the Inſtrument or Labouring Man to proceed and gain his Allowance; but to abbreviate this Obſervation the Allowance on this Head is leſſen'd long ſince in ſome Places, and the Contracter ſtill finds he can very well comply with the ſame.

The Second Article is, That in all Timber from 5 Inches thick to 18 Inches thick, the Price ſhall be allowed, according to the exact Superficies, which is 100 Foot for 100 Foot.

The Third Article is, That in all Timber, from 18 Inches thick to 24 Inches thick, the Allowance is Carſe and ⅓, or 75 Foot for 100 Foot, which is 108 Inches for 144 Inches, or for every 100 Foot you cut you are allowed 133 Foot, which is the Carſe and ⅓ over.

The Fourth Article is, That in all Timber, from 24 Inches deep, (or it may as well be term'd Square) to 36 Inches ſquare, the Carſe doubled, that is two for one, or for every 50 Foot cut to be allowed 100 Foot, which is for every 72 Inches 144 Inches, and for every 100 Foot that's cut the Allowance is 200 Foot, or double Pay.

The Fifth Article is, For all Timber that is 3 Foot deep, or upwards, the Allowance is 3 *d. per* Foot, for every Foot the Carſe is long, which is after the Rate of 9*s.* for 100 Foot, or for every 100 Foot that's cut you are allowed 300 Foot, which brings me to conſider the Reaſonableneſs of ſuch Allowances, and why 144 Inches is not the ſame Foot in a Piece of 3 Foot deep, as it is in a Piece of 1 Foot deep? Or whether it is for the ill Conveniency of bringing ſuch large Pieces to their Work more than in thoſe that are ſmaller; or that the Reſiſtance of cutting ſuch large Pieces to thoſe that are leſs, beyond an Arithmetical Proportion of their reſpective Dimenſions, by which Means the Motion of the Saw is retarded more than as 144 Inches is to 144 Inches.

As to the Firſt, It cannot be denied but that 144 Inches is the ſame Number in one Piece as 144 Inches is in the other Piece, tho' ever ſo different in their Bulk, and provided the Pieces are ſimilar in their Nature, that is either as to Clearneſs and Neatneſs of the Grain, or otherwiſe Rudeneſs or Knottineſs thereof, a Saw will move as faſt in a thick Piece as a thin Piece, provided the Depth of the Piece exceeds not the Swing or Moving of a Man's Arms; as I ſhall more fully conſider hereafter.

Indeed there is ſomething to be ſaid for the ill Conveniency of Pitting, or bringing large Timber to uſe, over what the Trouble is of bringing ſmall Pieces; but that at preſent chiefly lyes clear of the Sawyer, ſince all Timber in Publick Yards is brought to the Pits with the Horſes and Day Labourers; ſo that ſuch Faculties can be no Objection, nor Cauſe of an Extra Allowance more in a large Piece than in one that is ſmaller, and therefore ſuch an Allowance muſt be charged on the different Reſiſtance, or retarding of the Saw more in the great Piece than in the ſmall one, otherwiſe the Allowance is wrong placed; But to proceed to Particulars.

The Length of a Whipſaw is from 7 Foot 6 Inches to 7 Foot, but more commonly the Length is 7 Foot, according to a Medium Tallneſs that's obſerved in the Artificer. The Handles of the Saw take up ſix Inches of the Length, ſo that the Vibration may be allowed to be ſix Foot and ſix Inches, and the Number of Teeth in the whole Length being 56, every Tooth is 1 Inch and $\frac{39}{100}$ Parts of an Inch.

It may be obſerved, that a Sawyer's Stroke is 4 Foot, or more properly 4 Foot of the Saws Length generally cuts and no more, which muſt be counted from the upper Part downwards; ſo that the extra Length muſt be allowed for accelerating the Motion of the Saw, or it may be term'd the Percuſſion, or Stroke that the Workman makes to force his Saw through the Timber; which Conſideration will, in ſome Meaſure, lead me to the Knowledge Why the Price ought to be more in thick Pieces than ſuch as are thinner?

The Drift of the Saw is 18 Inches, ſo that it may be allowed that there is ſo much of the Saw uſeleſs as to cutting, and rather allowed to increaſe or force the Entrance of the Saw, than any ways ſerviceable towards Entering or Crumbling the Timber into Saw-duſt.

Now the Nature of Percuſſion was never abſolutely defin'd as I could read of, but it is generally believ'd that it is mightily increaſed by the Swing of the Hammer, as well, nay much more than by the Strength of a Man's Arm, ſince a ſmall Hammer may be made much more efficacious to force by one Man's Swing, than a very large Hammer can be made to force by a preſſing Weight, or any other Artifice that ſeveral Men together can uſe without ſuch Swinging.

That was any Piece of Timber as deep as the Saw is long it could not be cut or divided by ſuch a Saw: Notwithſtanding was any Piece of Timber ever ſo deep, and the Saw a proportionable Length to ſuch a Depth, alſo the Force or Artifice to work the Saw equal to that Length, then ſuch a Piece of Timber would be ſplit or divided, as ſoon as one that is ever ſo thin.

As for Inſtance, Let one Piece of Timber be 18 Inches deep, and another 36 Inches deep, then the Long Saw ought to be 15 Foot long, and of thickneſs agreeable to ſuch a Length, which in all likelihood would cauſe ſuch a Saw to increaſe the Weight according to the Square of ſuch doubling, and the Force requiſite to work ſuch a Saw or Engine, may well be required agreeable to the ſame, of which I ſhall make the ſucceeding Calculation.

By

The Depth of the Cut, or Square of the Timber, in Inches.		The Depth of the Pieces ſquared, which, as they are one to another, ſo will the Price be augmented, and ought to be allowed.		s.	d.	f.	The Price of the ſeveral Pieces *per* Hundred Foot on the Superficies.
18	———	324	———	3	0	0	
19	———	361	———	3	4	0	
20	———	400	———	3	8	2	
21	———	441	———	3	11	2	
22	———	484	———	4	4	2	
23	———	529	———	4	11	0	
24	———	576	———	5	2	0	
25	———	625	———	5	11	2	
26	———	676	———	6	3	0	
27	———	729	———	6	9	0	
28	———	784	———	7	3	2	
29	———	841	———	7	10	0	
30	———	900	———	8	4	3	
31	———	961	———	8	11	1	
32	———	1024	———	9	6	0	
33	———	1089	———	10	1	0	
34	———	1156	———	10	8	0	
35	———	1225	———	11	4	0	
36	———	1296	———	11	11	0	
40	———	1600	———	14	10	0	
44	———	1936	———	17	10	0	
48	———	2304	———	21	4	0	

By this Calculation it appears, that altho' I have fixed the Price of Oak at 3 *s. per* Hundred Foot on the Superficies, as far as a Piece of 18 In. deep; and that according to the Method deſcribed, it doth not amount to any more than 6 *s.* 3 *d.* until you come to a Piece 26 Inches deep, which is not ſo much as is generally allowed, but after that it lifts with a Vengeance: Notwithſtanding, I ſhall endeavour to prove ſuch great Prices for large Timber to be very reaſonable.

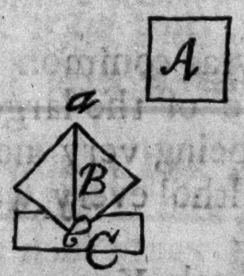
Firſt, It is undoubtedly manifeſt, that the Deepneſs of any Piece to be Sawed ſhortens the Saw, and is ſucceſſively a Hindrance from 18 Inches deep and upwards, in proportion to the Number of Inches ſquare there is in any large Piece.

Secondly, It ſeems to me very unreaſonable that the Allowance ſhould be the ſame in a Piece of 18 Inches deep, as in a Piece of 23 Inches deep; and alſo the ſame in one of 24 Inches deep, as in a Piece of 35 Inches deep; and that from 36 Inches upwards the Price ſhould be equal, as if the Difficulty was no more in a Piece of four Foot deep, than in one of three Foot deep.

Thirdly, That in caſe it ſhould happen in employing a certain Number of Sawyers, that it ſhould fall to one Man's Lot to cut always Pieces of 19 Inches deep; and for another Sawyer, or a certain Number of ſuch Men, always to cut Pieces of 23 Inches deep, I ſay it would be very hard for the Parties that cut Pieces of 23 Inches deep to loſe their Property, becauſe it is given to the other Parties that by chance cut ſuch Pieces that will be much eaſier cut, for in divers Caſes it may happen ſo, and yet no Fault in the Perſon that directs the Work.

Notwithſtanding, in another Place I have given ſome Reaſons, why few Cuts in Timber ought to be above 26 Inches deep, except in two or three out-ſide Cuts in ſlabing the large Pieces, and ſince it ought to be but ſeldom that deep Cuts ſhould be, and in all Probability the Workman ought to be provided with an Inſtrument ſuitable for ſuch Emergencies, it cannot be at all unreaſonable to allow him a Price according to this ſaid Calculation.

I paſs on now to the Cant-wiſe Pieces, or, as Shipwrights term them, Arras Pieces, as ſuppoſing the Square *A* was required to be cut according to the Poſition deſcribed in *B*, and was to be cut according to the Line *a b*, or Triangular Faſhion, which Pieces are generally ſo divided, to make Steps for Stairs in ſuch Places where the Deſign is not only for Mens paſſing up and down, but alſo for Timber, and other cumberſome Utenſils to be lower'd or raiſed for divers Uſes, according to what the ſaid Place is appointed for to do.

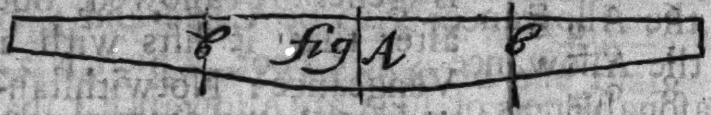


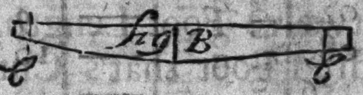
The Allowance on this Head is Carſe and Half, or 67 Foot to be cut for 100 Foot, ſo that for every 2 *s.* worth of Work there is 3 *s.* allowed for it, without having any regard to the Depth.

Which Allowance, in my Opinion, can be no otherwiſe allowed than for the Difficulty of Confining the Pieces in an Arras, Diamond, or Triangular Poſition, as may be ſeen in the Figure *B.* But ſuch a Conveniency may be made much cheaper than the Common Allowance.

For in caſe two Pieces were provided as Tranſums to lay thwart the Pit, as may be ſeen in Figure *C*, then ſuch Pieces may be cut with as much Facility as tho' they were Square, as may be ſeen in Figure *A*, and the Value of ſuch Proviſion not ¼ of the common Allowance which is made for cutting ſuch Work.

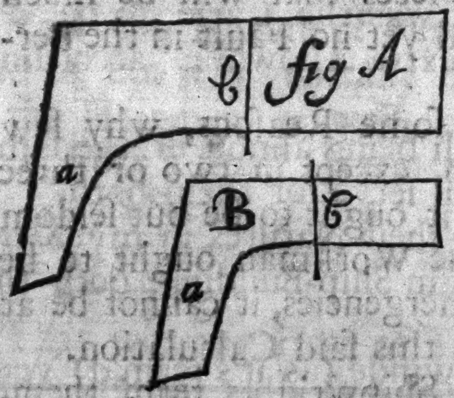
In the next Place I come to the Anchor-Stocks; where it's ſaid in the eſtabliſh'd Allowance, that for cutting them taper-wiſe, the Place of Meaſure ſhall be 30 Inches from the Middle, which being × by the Length ſhall be the Superficial Area of the ſame.

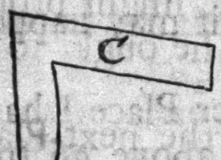


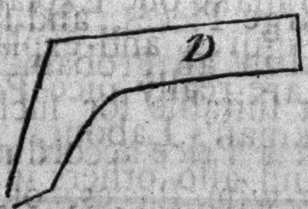


Therefore in the Figures *A* and *B*, I will ſhew this Error, and that it ſtill continues, for one Man to loſe his Property, and at the ſame Time it is given to another Man; for in the Figure *A* you may obſerve a large Anchor-Stock, that the Meaſuring Place will be at *b*, and very near the Middle, ſo that there will be a conſiderable Allowance; nay in very large Anchor-Stocks, the Meaſuring Place will make the Superficies almoſt a Parallelogram; but in ſmall Stocks, as *B*, you may obſerve the Meaſuring Place will be very near the ſmall Ends, as at *b*, ſo that the Workman will not have his due, and therefore it would be much better, that the exact Area was taken, provided the Meaſurer is able to caſt the exact Inches contained in ſuch a Figure; neither can I ſee any Reaſon that the Workman ſhould have more or leſs than the juſt Area for cutting ſuch Work.

I come now to Knee-Timber, where I cannot but obſerve the Partiality in this Particular, as well as in ſome others, ſince it may happen ſo that according to the various Growth in Timber the Workman may have a conſiderable Allowance for cutting ſome Sort of Knee Timber, and not one Farthing for Cutting another Sort, neither his Due in ſome Caſes; beſides, I am of Opinion that there requires an extra Allowance for this Sort of Work, from the Intricacy of the Utenſil, which is alſo increaſed by the Variety of the Shape; one or two Figures thereof will more fully illuſtrate the ſame.



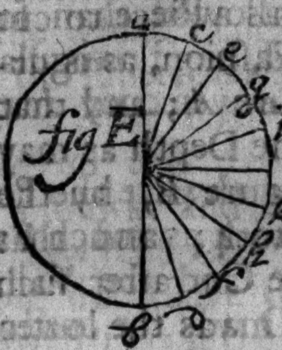




The Figure *A* ſhews the Shape of what is as generally called Knee Timber as any other Shape whatever, where may be obſerved, that *b* being the Place of Meaſure, it's conſiderably larger than the other Arm diſtinguiſh'd with an *a*, ſo that in ſuch Shapes there is an extra Allowance for cutting ſuch Work.

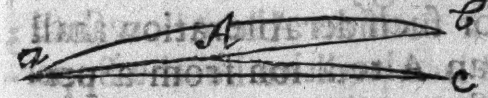
Now in the Figure *B*, which is another Shape every way as common as the other, it may be obſerved that *b*, being near the Middle of the largeſt Arm, is the Place aſſigned for the Meaſure, but the Arm *a* being very near equal in Bigneſs to the other, there is no Allowance at all, altho' every way as troubleſome to cut or divide as the other can be.

In another Caſe, as in the Figures *C* and *D*, which are both Knees, yet notwithſtanding *C* will be much more troubleſome to divide than *D*, according to the Angle made by ſuch Bending, which Proportion may be gain'd by



by Figure *E*, as may be ſeen by the perpendicular Lines, *a b* being in Imitation of a ſtrait Carſe where there is no Allowance, *c d* the firſt Degree of Bending, *e f* the Second, *g h* the Third, *i k* the Fourth; ſo that if it be thought reaſonable for the Sawyer to have a Penny or two Pence in the Hundred Foot for *c d*, then to be allowed more for *e f*, and ſo advancing the Price according to the extra Crookedneſs; and then for making the Middle of the longeſt Arms in Knees the Place of Meaſure, it would be much properer to make an Allowance of ſo much *per* Hundred Foot; all which ought punctually to be agreed on between the Maſter and Man, before any Contract be drawn between them.

In the next Place I come to rounding Carſes, or dividing ſuch Pieces as are crooked, where it's ſaid that any Piece that rounds from three Inches to five Inches, in twelve Foot Length, the Allowance is to be Carſe and $\frac{1}{4}$, or for every Hundred Foot that's Cut the Allowance is 125 Foot, which is 3 *d.* in every Shilling; but as to the Reaſonableneſs of ſuch an Allowance I ſhall conſider as follows, without taking Notice of what follows in that ſame Article.



In the Figure *A* you may obſerve two circular Lines, *a b*, and *a c*, one rounding three Inches in 12 Foot long, and the other 5 Inches: Now was a Whipſaw 12 Inches broad, whereof it is but 5 Inches broad at moſt, and neither of them Curves rounds in ſuch a Length as twice the Breadth of the Saw, to cauſe any Manner of Uneaſineſs to the Sawyer, but that he may make his Motion progreſſive, without bearing (as he terms it) his Saw either to one Hand or to the other.

But perhaps he may alledge, that in great Rounding his Pit will not be broad enough, but that he muſt either move his Piece, or otherwiſe his Pitman (as he terms him) will not have Room enough to ſtand and make the beſt Advantage of his Strength, which may be ſoon anſwered in making the Saw-Pits (where ſuch ſort of Timber is in common Uſe) larger; the Charge of doing ſo would be very little in Conſideration of what may be ſaved in doing of it.

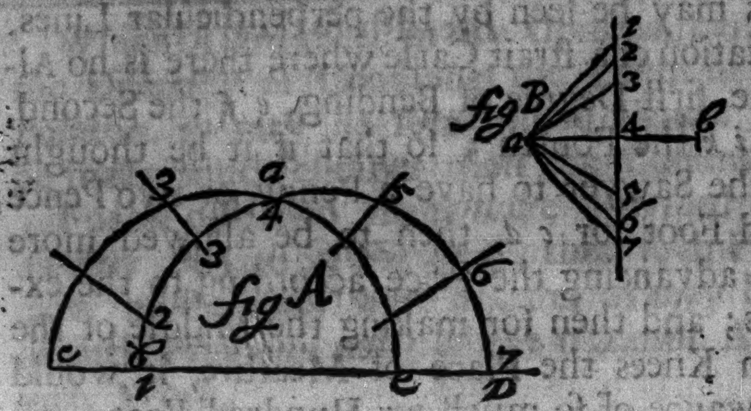
But in Carſes which are extream, or that round very much, ſo that the Turning of the Saw is effected, there indeed the Workman ſhould apply half his Strength to turn or bear his Saw (as he terms it) and of conſequence not cut half the Inches, which he might probably cut was the Carſe to be directly ſtraight, and therefore he ought to have an extra Allowance, according to ſuch a Hinderance.

Strings of Stairs come in the next Place, which being almoſt of the ſame Nature I ſhall endeavour to make one Explanation ſerve for them both.

I have laid down ſome Figures, and explain'd their Natures in my *Ship-Builder's Aſſiſtant*, and they are really nice Points in Ship-Building, both the Art-Part and alſo the Workman's Labour.

To Saw all ſuch Pieces, and alſo others which winde (as it's term'd) very much, is indeed very difficult; alſo to conſider the Care and Labour requiſite to perform ſuch Work, and bring it to general Heads, will require vaſt Conſideration, and therefore it will be much better for all ſuch Work to be done by a dayly Allowance; notwithſtanding I will give ſome Light how this particular Part of the Sawyer's Labour may be brought under general Heads.

In



In Caſe there was a Piece to cut into the circular Faſhion, as is deſcribed by the Figure *A*; and that the Piece was of the Depth as may be obſerved in Figure *B*, by the Line *a b*, from *a* to 4; and that the Piece was to be Cut after ſuch a Manner that *b D* was the lower Part, and *c e* the Upper, in the Nature of Screw or Twiſt-Work, as may be obſerved in cutting a Cylinder at Oblique Angles of any particular Depth aſſign'd in dividing ſuch a Cylinder.

Now foraſmuch as here are two Curves *b D*, and *e c*, altho' produced from one, or an equal Radius, it will be reaſonable to allow that there will be more Trouble in cutting this Piece, or the like, than will be in cutting two ſuch Lengths, ſo that the Allowance this way ſhall be as two to one; and ſince the Bevelling differs, as may be obſerved in the Figure *B*, and of conſequence the Piece muſt be alter'd at every one of the Marks, 1, 2, 3, *&c.* and at the Saws coming to them Marks the Piece muſt be altered, and put into a perpendicular Poſition, that the Working of the Saw may be direct for the Facility of the Artificer, then the Allowance made for ſuch an Alteration ſhall be adjuſted by taking a Medium Diſtance of ſuch an Alteration from a perpendicular Line; as in the Figure *B*, take the Diſtance from 4 to 2, or 6, and ſet from 6 to 4, and inſtead of making uſe of the exact Depth of the Piece, which is from *a* to 4, it ſhall be taken from *a* to *b*, and allowed according to my preceeding Tables of Roots to Squares; ſo that there will be allowed in this Caſe twice the Length for the Length, and the Depth with half the Depth added unto it, to caſt the Area of the Carſe.

I paſs on now to the Wedges, where it's ſaid that all Wedges cut out of Timber 18 Inches long, and 4 Inches ſquare at the Head, 80 of ſuch ſhall be counted 100 of Work; but if 100 of Wedges are cut out of Plank, they ſhall be deem'd 100 Foot of Work; of which I ſhall conſider in the following Scheme.

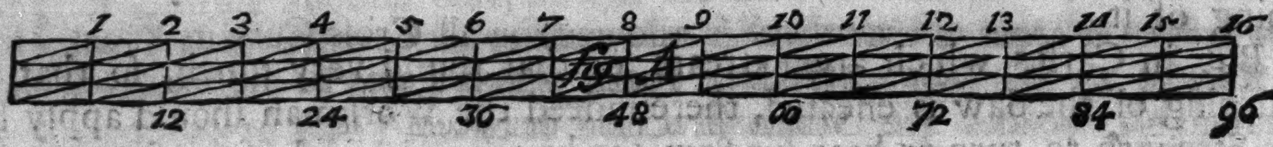


Figure *A* ſhews a Piece of Plank 1 Foot broad, and 24 Foot long, which will bear to be divided into 16 Diviſions, and every Sub-diviſion will again bear to make 6 Wedges, as may be ſeen by the Diagonal Lines in the firſt Diviſions; I ſhall allow this Plank to be ſomething better than 12 Inches broad, but ſhall be edg'd by the Sawyer to that Breadth, as giving the Workman all the Advantage that may be; then the Area cut Length-ways to make 12 Wedges will be 7 Foot, and to make 96 Wedges 56 Foot, however, I will add 2 Foot and a Half more for 4 Wedges, which will then make 58 Foot and a Half of Work, and then there will be 42 Foot allowed for 17 Croſs Cuts, which is near 2 Foot and a Half each; the Reaſonableneſs of which I ſhall more fully conſider when I come to mention all Croſs Cuts in general.

The different Number of Wedges allowed to be cut between Timber and Plank is 20, which will be 22 Foot of Sawing Work, and the Area in Slabing, or cutting the Timber into Plank, for every 100 of Wedges will be 32 which is 10 Foot Difference, or near nine Wedges; ſo that either the Sawyer that cuts Wedges out of Plank ſhould cut 109 Wedges, or he that cuts them out of Timber ſhould cut but 71, to make the Calculation exact and agreeable.

In cutting ordinary Deals, or ſplitting them with a Saw, 11 Deals is deem'd to be 100 Foot of work; now ordinary Deals are generally from 10 to

8 Foot long, and from 11 Inches to 9 Inches broad, that I will allow the medium Length to be 9 Foot, and Breadth 10 Inches; 11 × by 9 is 99, which is the whole Length, and that × by 10 Inches the Breadth makes 83 Foot, for the ſuperficial Area; ſo that the Area inſtead of 100 Foot is but 83 Foot, which is 17 Foot leſs than what is allowed to the Sawyer, that the trueſt Way on this particular is to meaſure the exact Feet contain'd in the Sawyer's Work, and make his Allowance from that; however, ſince this Part of the Sawyer's Labour is various as to the Allowance of doing it, the Prices being not above half in ſome Places of what they are in others, it muſt be allowed that if thoſe that have the large Prices have but their due, the others that have the ſmall Rates muſt conſequently be Starved.

For Whetting of a Whipſaw, the Price is one Shilling, and for a Two-hand Saw Two Pence, which Price of Whetting is very near the Prices of the Saws, which, in my Opinion, is adjuſted by the Goodneſs of the Materials; and for Cutting and Toothing a Whipſaw 4 *s.* 6 *d.* which Whetting and Toothing ought to be very well performed, both for the Diſpatch and Niceneſs of the Work; the Setting, as well as Sharpening and Toothing, ought to be curiouſly ordered, that the Saw may not direct it ſelf to one Hand more than to the other. But to proceed to the Sawing Part, and now to the Croſs Cuts.

Croſs Cuts in Timber.

	Inches Square	Area in Inches	Ft.		Ft.		
	36	1296	9	The Allowance is	25	The Proportion of the Allowance is to the Area, as,	3 to 8
	28	784	$5\frac{44}{100}$		14		7 to 18
Under	28	784	$5\frac{44}{100}$		11		1 to 2
	17	289	2		8		1 to 4
Under	17	289	2		5		2 to 5

Croſs Cuts in Plank.

			Ft.		Inch.		
4	In. thick, and 16 In. broad	64 Inch. Area.	4	The Allowance.	576	The Proportion of the Allowance is to the Area	1 to 9
3		48	3		432		1 to 9
2		32	2		288		1 to 9

By which it appears that there is allowed for all Croſs Cuts in Plank after the Rate of 27 Shillings a Hundred Foot, which ſeems to me extravagantly unreaſonable, beſides the Miſconſtruction between the Allowance in large and ſmall Timber, ſince in the largeſt Timber it is not 6 Shillings *per* Hundred, and, I am poſitive, much more reaſonable for the largeſt Timber to have the greater Allowance from the Hazard there is, and alſo Artifice required to part or divide it.

However, I cannot deny but that there ought to be a conſiderable Allowance given to the Sawyer for the Difference there will be between dividing the Timber Thwart-wiſe and Length-wiſe, which nicely to define I have not thought of yet, but only by Tryal, in ſtriking a ſtroke Length-wiſe into a Piece of Timber, and alſo Croſs-wiſe into the ſame Piece, with an Ax well ſharpened, and alſo, as near as poſſible, with equal Force, and found the Entrance to be as three to one, that is the Ax enter'd Length-wiſe three times as far as it did Croſs-wiſe; from which I am of Opinion that an Ax, or any other cutting Tool may meet with a Reſiſtance equal to that, and therefore the Price ought to be accordingly, only that the Price ought to advance in the large Cuts, and not in the ſmall Cuts, having experienced a Sawyer to gain 13 Shillings for one Day's Labour, for Cutting Croſs Cuts, in two Inch and three Inch Plank.

However, I ſhall calculate a Table for ſuch Work, and allow it according to a moderate, but a very ſufficient Allowance.

Croſs Cuts in Timber.

Inches Square.	Area in Inches	The Allowance at 1 to 3 is.	
36	1296	9	27
34	1156	8 1/20	24 3/20
32	1024	7 3/10	21 9/10
30	900	6 1/4	18 3/4
28	784	5	16 1/2
26	676	4 3/4	14 1/4
24	576	4	12
22	484	3 4/10	10 2/10
20	400	2 8/10	8 4/10
18	324	2 1/4	6 3/4
16	256	1 8/10	5 4/10
14	196	1 [illegible]	4 8/10
12	144	1	3
10	100	100/144 +	2

Croſs Cuts in Plank.

Inches thick.	Inches broad, which is the common Breadth at preſent.	Area in Inches.	The Allowance as the Proportion of 1 to 3.
9	26	234	702
8	24	192	576
7	20	140	420
6	17	102	306
5	14	72 1/2	217 1/2
4	13	52	156
3	11	33	99
2	10	20	60
1			

The Allowance in Inches, divided by 144 is,	In Feet,	The Allowance as 1 to 3.
702	4 [illegible]	14 [illegible]
576	4	12
420	2 [illegible]	8 [illegible]
306	2 [illegible]	6 [illegible]
217	1 [illegible]	4 [illegible]
16	1 [illegible]	3 [illegible]
199	[illegible]	2 [illegible]
60	[illegible]	1 [illegible]

Theſe Calculations are after the Rate of 9 *s. per* Hundred, which cannot be under a ſuitable Allowance for the Workman, and in the large Cuts it tops the common Allowance, which are the Cuts in my Opinion that ought to exceed the Small, provided it be reaſonable to make a Difference; but obſerving that in cutting Timber Croſs-wiſe, it's little other than rubbing the Grain by main Strength, without any Artifice of a Swing, or forcing by a Stroke or Percuſſion of the Saw; ſo that the Difference in my Opinion is not much between large Cuts and ſmall ones.

I come now to the Allowance which is given by the Day or Tide to the Sawyer, in the which I ſhall be pretty brief.

A Sawyer that generally works by the Hundred, if he has ſuch Work as cannot be adjuſted that way, then he is allowed 125 Foot, or three Shillings and nine Pence for one Day, and for one Hour 12 Foot, or 4 *d.* ½, and for a Tide 38 Foot, or 1 *s.* 1 *d.* ¾. Which Calculation ſeems ſomething odd, ſince a Tide is but one Hour and a half, and that the Sawyer ſhould be allowed for that as much as for three Hours is ſomething ſtrange; but believing it to be rather for want of an Illuſtration, and that the Meaning muſt be thus, that the Hour is to be between ſix a Clock in the Morning and ſix at Night, and the Tide to be work'd before the proper Hours a Man is to do his Day's Work, and after ſuch a time, as I ſhall more particularly hint in my Obſervation of Calker's Work, and ſhall paſs on to conſider ſomething of Lumping the Sawing Work, or Sawing by the Tun, as has been frequently uſed in ſome Places.

650. 80 12
20 300
1600 3600
650(1600(2 65(3600(05
1300 325
300 450

I have been told that at *Southampton* a Ship of 650 Tun, has had all her Sawing Work done for 80 Pounds, which is but 2 *s.* 5 *d.* and 45/65 Parts of a Penny *per* Tun; which to me ſeems ſtrange, ſince in the River there has been given from 7 *s.* to 4 *s. per* Tun, according to the Bigneſs of the Ship: Neither doth it ſeem reaſonable to me that ſuch Work ſhould be Tasked above all others, ſince the Performance thereof will be ſo very various, as I ſhall inſtance, in two or three Particulars, and proceed.

Firſt, To be ſure every Part ought to be nicely numbered, as what Parts ſhall, and what ſhall not be ſawed.

Secondly, That the Sawyer may be ſure his Buſineſs will be continual, according to the Number of Hands he engages himſelf to employ.

Thirdly, That all defective Plank and Timber be adjuſted, who ſhall be at the Charge of Sawing it, Whether the Builder or Sawyer.

Fourthly, Whether the Builder or Sawyer ſhall be at the Charge of bringing the Timber to the Saw-Pit: All which Cautions being duly obſerved, in the next Place I proceed to conſider of the Area, or Superficial Feet, that is cuſtomary to be ſawed in any Ship, according to her different Magnitude; The Plank which is generally provided in the Woods, as 4 Inch, 3 Inch, and 2 Inch Plank, which Material ought not to be reckoned the Sawyer's Buſineſs in Lumping his Work.

And therefore what the Sawyer is to cut is all thick Stuff, and every Part of the Frame, excepting Plank.

I ſhall therefore begin, and allow my Calculation as follows, That the Lengths ſhall be taken from Stem to Stern, between the Lower-Wale and the Keel; and for the Breadth take the Girt of the Body, from the Ship's Keel to the Top-timber Head, which two Dimenſions × together ſhall be the Superficial Content of one Side: then I allow four ſuch Sides, ſince there is two Outſides and two Inſides to every Ship.

Then in all Ships that have thick Stuff, as Clamps, Spirkit-riſings, Wales, and Strakes, between the Wales and other Stuff that tapers, the Thickneſs of the Wale, to 4 Inch Plank there may be an Allowance of three Superficies; then for the Edging of Plank and Croſs Cuts, I ſhall put oppoſite to the Space between the Timbers; then for ſlabing the Timbers, which is generally done before they are Moulded, and that the Depth Rough conſiderably over tops what the Timbers are after they are converted, I ſhall allow as much for the In and Out-way as for the Moulding-way; as for the Moulding way, that there will be four Superficies to be added to ſeven Superficies which will make 11 Superficies from the Keel to the Top-timber Head, and from Stem to Stern of one Outſide; ſo that, without mentioning the Keel, Stem, Poſt, Beams, Tranſums, and the like, I ſhall proceed to the Calculation, obſerving that no Ship under 1000 Tuns ought to be calculated with 11 Superficies, as I ſhall put in order in the proceeding Calculations.

The Tunnage of ſix Ships.	Medium Length between the Wale and the Keel.	Length of the Girt between the Keel and the Top-timber Head.	The Area is	Number of Superficies
1703	172	58	9976	11
1450	166	55	9130	11
1004	150	44	6600	11
670	129	36	4644	9
370	105	31	3255	8
261	90	25	2250	8

The Area × by the Number of Superficies.	Total Area = by 100, is 100 Foot.	Price *per* Hundred Foot.					Price *per* Tun.		
		s.	l.	s.	d.		s.	d.	q.
109736	1097 $\frac{36}{100}$	5	274	10	10	or	3	3	0
100430	1004 $\frac{30}{100}$	5	251	5	6	or	3	5	2
72600	726	4	145	4	0	or	2	10	3
41796	417 $\frac{96}{100}$	3	73	4	10	or	2	2	0
26040	260 $\frac{40}{100}$	3	39	3	2	or	2	1	1
18000	180	3	27	0	0	or	2	0	3

You ſee my vulgar Method of Calculating this Branch; notwithſtanding, for fear I have rated the largeſt Ships under the Allowance, which may be requiſite in cutting large Timber, as may be made uſe of in compoſing them, I ſhall allow the large Ships 7 *s. per* Hundred throughout, and proportion the other from the Cube Root of each reſpective Ship's Tunnage, and make ſome Difference in the Proportion of the large Ships, judging it to be more feaſible.

The Medium Length in Ft.	The Medium Breadth, or Girt is in Feet	Area.					
172	58	9976	11		109736		1097 $\frac{36}{100}$
166	55	9130	11	Areas ×	100430		1004 $\frac{30}{100}$
150	44	6600	11	by the	72600	= by	726
129	36	4644	9	Number	41796	100, is	417 $\frac{26}{100}$
105	31	3255	8	of Sides,	26040		260 $\frac{40}{100}$
90	25	2250	8	is,	18000		180

These

Hundred Feet	Rate *per* 100 Feet. s.	d.	Total Sum for Sawing each Ship. l.	s.	d.	Price *per* Tun for each Ship Sawing s.	d.
1097 36/100	7	0	384	13	6	4	6
1004 30/100	6	9	339	1	6	4	8
726	6	0	217	16	0	4	4
417 96/100	5	0	105	5	10	3	0
260 46/100	4	3	55	13	11½	3	0
180	3	9	33	15	0	2	7

Theſe Calculations have only reſpect to the bare Sawing without any Allowance for Hindrance, either one way or another; for the Defects that way, as I caution'd before, will be ſo very promiſcuous that it will be altogether impoſſible to enumerate them; ſince in ſome Places, and according as Timber is ſtored up, it may require as much Time and Charge to obtain the Timber and bring it to Uſe, as the Timber is worth Sawing, which in good Care of Purveying and Receiving may be prevented.

But in Caſe that the Sawyer is oblig'd to bring his Timber to Hand, and the Conveniency for doing it not very good, his Pains and Trouble for ſo doing may be every Way as chargeable as the Sawing, and he ought to have a Price double to what is mention'd in this Calculation; but if the Builder provides Labourers to bring the Timber conveniently to Hand, that is to the Saw-pit, and take care that the Sawyer is in no Caſe hindered, but that the Moving of the Saw may be continual, without any Intermiſſion, then theſe Calculations and Allowances will be ſufficient, and a very good living Price for the Sawyer's Labour in every Particular.

I ſhall end this Obſervation with one plain Inſtance to find what the bare Sawing Work is worth *per* Tun, from the Length of the Lower Gun-Deck, and Breadth from Outſide to Outſide of the Ship, at the extream Breadth. *Example.*

Take the Length of the Lower Deck from Rabit to Rabit, and the extream Breadth, and add them together; then find the Cube Root of that Number; when you have ſo done = that Sum for all Ships above 1000 Tuns by 1-32, and for all Ships under 1000 Tuns by 1-9, which will give you the Price *per* Tun Sawing as aforeſaid.

Example, A Ship of 168 Foot Length on the Deck —— 168
Breadth extream from Outſide to Outſide —— 48
Sum'd is 216

Cube Root of 216 is 6, = by 1-32 it's 4-54, which is 4 Shillings 6 Pence ½, *per* Tun

Foot.
Example the Second, A Ship of 99 Foot Length on the Deck — 99
Breadth from Out to Out —— 26
125

Cube Root of 125 is 5, = by 1-9 it is 2-61/100, or 2 Shillings and 7 Pence ½ *per* Tun.

TO

TO
Forge IRON,
OR THE
SMITH's Contract.

THIS Branch of Ship-Building is very extenſive, not only from the almoſt numberleſs Parts belonging to the ſame, but the Operation being ſo very intrinſick that it's almoſt paſt Skill to explain it as to the Increaſe and Decreaſe of a ſuitable Fire; the Effect of Bellows, or Blaſt, to raiſe the Fire; the Waſte that's made by Working or Forging the Iron in the Fire.

And firſt of the Increaſe or Advantage which is cauſed by the Fire: Sir *William Petty*, in his *Duplical Proportion*, ſpeaks ſomething of that Nature, but leaves it dark; ‘ For, ſays he, let a Cylindrical Flat-bottom Veſſel be fill'd with Water, and let it be tried in what time one Lamp, or Candle, will make the Water boil through, or come up to its greateſt Height, then ſee how much leſſer time two, three, or four more like Fires will haſten the ſame Effect. I cannot, he adds, ſpeak poſitively hereof, but know from ſeveral Obſervations, that the Acceleration aboveſaid ſhall not be made in an Arithmetical Proportion; foraſmuch as that in Fire-works great Fires are more profitable than ſmall, as in Brewers Coppers and Iron-works may be ſeen wherein double Fires produce more than double Diſpatch or Advantage’; and ſo ſuſpends that Subject.

The ſame Author mentions again, in another Place, concerning the Effect of Bellows; as in Iron work Furnaces are the greateſt and moſt regular moving Bellows that are any where uſed, the which are commonly turned by the eveneſt overſhot Wheels: Now the Times wherein theſe Bellows riſe and fall are the Roots of the Strength of ſuch Bellows Blaſt upon the Fire; for riſing in double Quickneſs admits double Air in the ſame time, which being in like manner ſqueezed out again, double Quickneſs makes double Expulſion, and conſequently double Swiftneſs, (the whole paſſing thro' the ſame Twire-Pipe in half the Time) and double Swiftneſs makes quadruple Effects upon the Fire, or Furnace, as aforeſaid, which ſeems a reaſonable Demonſtration of the Effect of Bellows upon the Fire; but that being not wholly to our preſent Purpoſe, any farther than joining to the Operation made by the Workman on the Iron; and ſo I proceed to conſider the Nature of the Fire, and a proportional Quantity of Coals proper to forge, or do any Piece of Iron-work that is uſeful towards compoſing the Machine.

Firſt I ſhall begin with the Quantity of Coals, which may be thought proper to make the ſmalleſt Fire for heating Iron ſo as to make it malleable, which I ſhall allow to be half a Peck, or 272 Inches; I ſhall alſo allow the Shape of ſuch Fires to be a perfect Hemiſphere, arching upwards, ſo that the Diameter of the Sphere or Fire on the Hearth will be 8 Inches, and that this Fire ſhall be of a ſufficient Bigneſs to heat a Bolt, or any other ſhap'd Iron of half an Inch Diameter, then there will be in the Fire of the ſaid Iron 7 Ounces and 3/20 of an Ounce; the Weight of the Gallon of Coals will be 12 Pound, ſo that the Weight of Iron to the Weight of Coals will be as 3 to 80, from which I ſhall produce a Calculation for the Weight of the Coals proper to the Weight of Iron, for any Bolt that is generally wrought; and ſince Bolts are the commoneſt Parts that are uſed Aboard of any Ship, or to compoſe the Machine, I ſhall ſet down the Weight of one Foot of Bolt of every ſize, beginning with a half Inch Bolt, from which I ſhall hereafter give a juſt Account what Quantity of Iron may be reaſonably required to be drove into any Ship, according to the Bulk and Magnitude thereof.

The Diameter of the Bolt in Inches and Parts, which Sizes are the biggeſt and leaſt that are commonly uſed in Ship-work.		The Weight of 1 Foot Length of the ſeveral Sizes in Pounds and Ounces, the Proportion of which Weight will be found from the Square of the ſeveral Diameters.			The Square of the Diameter of each Bolt.	The Inches and Parts contained in a Foot Length of the ſeveral Sizes of the Bolts.	
Inches.		*l.*	*ounces.*			*Inches.*	
0	1/2	0	10	7/10	64	2	34/100
0	5/8	1	0	7/10	110	3	69/100
0	3/4	1	8		144	5	27/100
0	7/8	2	0	1/2	196		
1	0	2	10	1/2	256	9	36/100
1	1/16	2	15	1/2	289		
1	1/8	3	6		324		
1	3/16	3	11	3/4	361		
1	1/4	4	2		400	14	76/100
1	5/16	4	9		441		
1	3/8	5	1		484		
1	7/16	5	8	1/4	529		
1	1/2	6	0		576	21	8
1	9/16	6	8		675		
1	5/8	7	0	1/4	676		
1	11/16	7	8	1/4	729		
1	3/4	8	1		784		
1	13/16	8	10		841		
1	7/8	9	4		960		
1	15/16	9	14		961		
2	0	10	8	1/2	1024	37	44/100
2	1/8	11	14		1156		
2	1/4	13	6		1296		

I have hitherto conſidered a direct hemiſpherical Fire, but in regard that the Back will be very Efficacious (towards heating) if rightly conſider'd, I ſhall only allow half the Quantity of Coals afore-mention'd, or 136 Inches ſuitable for a Fire to heat any piece of Iron which ſhall be equal to a Bolt of half an Inch Diameter, then the Weight of Coals to comply with ſuch a Fire will be 6 Pound, and the Iron in the Fire will be 7 Ounces 3/20, the Proportional weight of Coals to Iron will be as 40 to 3; ſo that 40 Pounds of Coals will be ſufficient to heat 3 Pounds of Iron, either for Weilding or Hammering.

I will allow that a Smith may heat this 7 Ounces 3/20 of Iron in ſuch a Fire, either fitting for Hammering or Weilding in 3 Minutes, the Hammering or Working of it incluſive, ſo that between the Hours of 4 a Clock in the Morning and 9 at Night, (the common Day for ſuch Artificers) only abating 2 Hours for Breakfaſt-time and Dinner-time; then one Smith as a Hammer Man, and one Boy at 2/3 Wages, ſhall Work up 136 pound and 8/19 of ſuch Iron in ſuch a number of Hours, the Man's Wages I ſhall Rate at 22 Pence *per* Day, and the Boy's at 14 Pence, is together 3 *s. per* Day.

The Coals that are requiſite to forge ſuch Iron, I ſhall allow to be equal to the Weight of the Iron; not that I would be taken to meaſure this Allowance from the Laws of the Hydroſtaticks, where it's ſaid the Water will neither bear more or leſs than a Body as ponderous as it ſelf, if I may be allow'd the Expreſſion; neither can it be abſolutely taken the ſaid way in all Caſes, ſince there is the Goodneſs of the Coals, the Diſpatch of the Artificer, and ſeveral intervening Circumſtances, which will require more or leſs Time according to the Curioſity of the Jobb you have in Hand, but at preſent I am only conſidering the Forging of Bolts, or ſuch rude Material which are near ſimilar to each other according to the Bulk; notwithſtanding I am of Opinion that two Bodies equally ponderous, may conſume one another by there equal Strength in the ſame Time.

Then let 136 pound and 1/10 of Coals be allowed for this or ſuch a Day's Work, which will be one Buſhel 6 Gallons and 6/100, allowing Coals to be provided at 29 Shillings a Chaldron, which is 9*d.* half Penny a Buſhel, then the Charge of Coals will be 1 *l.* 1 *s.* 1 *d.* 1/2.

Now the Waſte in Forging the Iron will be as intricate to define as any other Matter, ſince it depends chiefly on the Management of the Artificer in heating the Iron, that is, in heating it beyond a ſuitable Degree to hammer it. The Waſte may be term'd the Cruſt or Outer-part, which by the Over-heat of the Fire is made much harder than the Inſide, and ſo in Hammering beat off by the Percuſſion or Force of the Blow, and muſt be allowed more or leſs according to the Bulk of the Iron to be Wrought.

I ſhall allow this Waſte or Cruſt cauſed by heating and hammering the Iron, to be in the general 1/20 of the whole Weight, ſo that 1/20 of all Iron that is forged I allow to be Waſte; not but that there will be alſo ſome Difference that will ariſe in Pieces that are brought from the Furnace to the Forge, much larger than what is purely Requiſite, and that I take to be rather a Neglect in the Provider, than any reaſonable Cauſe for an Allowance.

I come now to calculate a Table for a general Allowance of Coals ſuitable to the Weight of Iron for the ſeveral Sizes ſpecified, in which I ſhall firſt allow the Calculation to be as 80 to 3, to find the Diameter of the Fire, or Spherical Figure, and then the 1/2 of that ſhall be the Quantity of Coals proper to make a Fire for the ſeveral Sizes of Bolts as follows:

The Diameter in Inches and Parts. In.	The Weight of Iron in the Fire will be but 7 Ounces 13/20, but for the Proportion ſay, as 10 Ounces 7/12 is to 12 pound of Coals, ſo is all the other Weight of Coals to their Reſpective Weights of Iron in the Fire. l. ounces.	The Weight of the Coals. l. oun.	The Weight of Coals brought into Pints and Gallons. gal. pts.	The Weight of Coals brought into Inches; which Inches reduced into a ſolid Globe or ſpherical Figure, the Diameter of which is the Length of each Bolt in the Fire, and from thence the Weight of the Iron to be heated may be known. Inches.	The Length of the Bolt in the Fire in In. and Pts. Inc.	The Weight of the Bolt in the Fire in Pounds and Ounces. l. ounces.
3/4	0 0 7/10	12 0	1 0	272	8	0 7 3/20
13/16	1 0 7/10	18 12	1 4 1/2	425 1/2	9 1/2	0 13
7/8	1 8	27 0	2 2	612	10 3/16	1 5
15/16	2 0 1/2	36 0	3 1 1/4	838 3/4	11 1/16	1 15 7/8
1 0	2 10 1/2	47 2	3 7 1/2	1071 1/2	12 1/16	2 12 1/2
1 1/16	2 15 1/2	53 4	4 3 1/2	1207 1/2	13 3/8	3 4 1/2
1 1/8	3 6	60 12	5 0 1/2	1377	13 1/16	3 14 1/2
1 3/16	3 11 3/4	67 8	5 5	1530	14 5/8	4 7 1/2
1 1/4	4 2 1/2	74 8	6 1 1/2	1683 1/2	14 1/16	5 2 1/2
1 5/16	4 9	82 0	6 6 1/2	1853 1/2	15 3/8	5 13 1/2
1 3/8	5 1	91 0	7 4 1/2	2057 1/2	15 1/16	6 1
1 7/16	5 8 1/4	99 0	8 2	2244	16 1/4	7 8 3/4
1 1/2	6 0	108 0	9 0	2488	16 7/8	8 6
1 9/16	6 8	117 0	9 6	2692	17 1/8	9 3
1 5/8	7 0 1/4	126 0	10 4	2856	17 5/8	10 3
1 11/16	7 8 1/4	135 0	11 2	3060	18	11 4
1 3/4	8 1	145 0	12 0 1/2	3281 1/2	18 1/2	12 7
1 13/16	8 10	156 0	13 0	3536	18 3/4	13 7
1 7/8	9 4	166 0	13 1 1/2	3791 1/2	19 1/4	14 10
1 15/16	9 14	178 0	14 7	4046	19 3/4	16 0
2 0	10 8 1/2	190 0	15 7	4318	20 1/4	17 12

I Proceed now to ſhew the Weight of the Coals agreeable to the Weight of the Iron, the Proportion of which will be as 40 to 3, which is the exact Allowance without Halveing.

l.	oun.	l.	ounces.	Buſh.	gal.	pints
Weight of the Iron.		Weight of Coals agreeable to ſuch Weights of Iron.		The Weight of Coals brought into Buſhels, Gallons, and Pints.		
0	$7\frac{3}{20}$	6	0	0	0	4
0	13	10	3	0	0	$6\frac{3}{4}$
1	5	17	8	0	1	$3\frac{3}{4}$
1	$15\frac{7}{8}$	26	8	0	2	$1\frac{3}{4}$
2	$12\frac{1}{2}$	36	0	0	3	0
3	$4\frac{1}{2}$	43	7	0	3	5
3	$14\frac{1}{2}$	51	8	0	4	$2\frac{1}{2}$
4	$7\frac{1}{2}$	59	4	0	4	$7\frac{1}{2}$
5	$2\frac{1}{2}$	68	0	0	5	$5\frac{1}{2}$
5	$13\frac{1}{2}$	77	8	0	6	4
6	11	89	0	0	7	$3\frac{1}{2}$
7	$8\frac{1}{2}$	100	0	1	0	3
Weight of Iron.		Weight of Coals agreeable.		The Weight of Coals brought into Buſhels, Gallons and Pints.		
8	6	111	0	1	1	2
9	3	122	0	1	2	$1\frac{1}{2}$
10	3	135	0	1	3	2
11	4	150	0	1	4	4
12	7	166	0	1	5	$6\frac{1}{2}$
13	7	181	0	1	7	0
14	10	196	0	2	2	0
16	0	212	0	2	1	5
17	2	228	0	2	3	0

By this Calculation it appears, that the Bolt which is 2 Inches in Diameter, is allowed 2 Buſhels and 3 Gallons of Coals to make a Fire ſuitable for heating the ſame; not that I would be thought to inforce a Waſte in the Material, or oblige any Smith to make a larger Fire then what he can tend, but only to bring ſuch Mechanical Operations to general Heads, allowing that ſuch Fires ſhall have equal Effect upon the ſeveral Sizes of Bolts, and heat one (or largeſt ſize) in the ſame Time, as the other of the ſmalleſt is heated by the little Fires, and that ſuch large Fires well tended with a proper number of Men, according to the Areas of the Bolts ſuitable to the ſame, may draw, or work an equal Number of Feet in each reſpective Bolt, in the ſame or equal Time, of which having conſidered, I ſhall make ſuitable Calculations as follows.

In.	In.		Inches.		Minu.		l.	
Diameter of the Bolt in Inches and Parts.	The Superficial Area of each Bolt is 8 Inches Length, from which I ſhall ſhew it in each Bolt's Length in the Fire.		The Superficial Area of each Bolt in the Fire, and from theſe Superficies will be found the Proportion of Time Requiſite for working the Iron, and from thence the Value of it; for if 12 Inches $\frac{6}{10}$ Superficies, Requires 3 Minutes to heat it in and Work it off, what ſhall the other Superficies Require.		The Minutes and Parts Requiſite to work each Piece of Iron, in and out of the Fire.	The Times that each Bolt ſhall be heated and worked off in one Day, and from thence to know how many Hundred Weight of each Bolt ſhall be ſo Wrought.	The Quantity of Iron one Man and a Boy, as aforeſaid, may work in one Day, according to the Superficial Area of each ſized Bolt.	
0 $\frac{1}{2}$	$12\frac{6}{10}$		$12\frac{6}{10}$		3	300	$136\frac{8}{10}$	
0 $\frac{5}{8}$	15	7	$17\frac{9}{10}$		$4\frac{1}{4}$	200	$162\frac{8}{10}$	
0 $\frac{3}{4}$	18	9	$24\frac{7}{10}$		$5\frac{9}{10}$	152	$197\frac{6}{10}$	
0 $\frac{7}{8}$	22	0	$32\frac{9}{10}$		$7\frac{8}{10}$	114	222	
1 0	25	2	$40\frac{8}{10}$		$9\frac{3}{4}$	$92\frac{1}{2}$	256	2
1 $\frac{1}{16}$	26	8	44	9	$10\frac{3}{4}$	83	272	3
1 $\frac{1}{8}$	28	2	48	9	$11\frac{3}{4}$	77	296	
1 $\frac{3}{16}$	29	9	53	3	$12\frac{3}{4}$	70	316	
1 $\frac{1}{4}$	31	5	58	0	$13\frac{8}{10}$	65	334	
1 $\frac{5}{16}$	33	0	63	2	$15\frac{1}{4}$	$59\frac{1}{4}$	349	
1 $\frac{3}{8}$	34	6	68	8	$16\frac{4}{10}$	55	364	
1 $\frac{7}{16}$	36	2	73	6	$17\frac{1}{2}$	$51\frac{3}{4}$	380	
1 $\frac{1}{2}$	37	6	79	0	19	$47\frac{1}{2}$	396	
1 $\frac{9}{16}$	39	3	84	6	$20\frac{2}{10}$	$44\frac{3}{4}$	412	
1 $\frac{5}{8}$	40	9	90	0	$21\frac{1}{2}$	42	427	
1 $\frac{11}{16}$	42	5	95	5	$22\frac{3}{4}$	$39\frac{1}{2}$	443	
1 $\frac{3}{4}$	44	0	101	0	24	$37\frac{1}{2}$	459	
1 $\frac{13}{16}$	45	5	106	5	$25\frac{4}{10}$	$35\frac{1}{4}$	475	
1 $\frac{7}{8}$	47	0	112	8	27	$33\frac{1}{2}$	490	
1 $\frac{15}{16}$	48	6	119	0	$28\frac{5}{10}$	$31\frac{1}{2}$	506	
2 0	50	4	128	0	$30\frac{5}{10}$	$29\frac{1}{2}$	$522\frac{1}{10}$	

The Weight of the Coals being equal to the Weight of Iron in the Fire, is agreeable to the laſt Calculation, which I ſhall proceed to reduce into Buſhels, Gallons and Pints.

Pounds

The Quantity of Iron one Man and a Boy may Work in one Day.	The Quantity of Coals to heat in Buſhels, Gallons and Pints.			Value of the Coals at 9 *d.* ½ penny a Buſhel, to perform one Day's Labour on the ſeveral Sizes of Iron, to which I ſhall ſubjoin the Value of the Workman's Labour.			The Value of the Workman's Labour for one Day.		The Value of Coals and Workman's Labour put together for to do one Day's Work as has been afore-mentioned.		
Pounds.	*buſh.*	*gal.*	*pts.*	*s.*	*d.*	*fa.*	*s.*	*d*	*s.*	*d.*	*fa.*
136 8	1	3	2⅔	1	1	2	3	0	4	1	2
162 8	1	5	4	1	3	3½+¼	3	0	4	3	3¾
197 6	2	0	3	1	7	1½	3	0	4	7	1
225	2	2	6	2	0	0	3	0	5	0	0
256 2	2	5	4	2	3	0	3	0	5	3	0
272 3	2	6	6	2	4	3	3	0	5	4	3
296	3	0	5	2	7	0½	3	0	5	7	0½
316	3	2	3	2	9	0¾	3	0	5	9	0¾
334	3	3	7	2	10	0½	3	0	5	10	0½
349	3	5	0	3	0	1½+¼	3	0	6	0	1¾
364	3	6	3	3	1	0½+¼	3	0	6	1	0½+¼
380	3	7	5	3	2	1½+¼	3	0	6	2	1½+¼
396	4	1	0	3	4	1¾	3	0	6	4	1¾
412	4	2	2	3	5	3	3	0	6	5	3
427	4	3	5	3	7	1½	3	0	6	7	1½
443	4	4	7	3	9	0	3	0	6	9	0
459	4	6	1	3	10	2	3	0	6	10	2
475	4	7	5	4	0	1	3	0	7	0	1
490	5	0	6	4	3	2½	3	0	7	3	2½
506	5	2	1	4	5	3½+¼	3	0	7	5	3½+¼
522 $\frac{15}{100}$	5	3	3	4	7	1½	3	0	7	7	1½

Theſe Calculations would ſeem a Paradox to ſeveral Perſons, that the Labour of Working 522 Pounds of large Iron of 2 Inches Diameter, ſhould be no more than the Working 136 Pounds of ſmall Iron of ½ an Inch Diameter, and perhaps they may be ready to Object and Averre it to be Impoſſible, without Inquiring into the Reaſonableneſs of the Caſe. For, indeed, to look upon a ſquare Bar ſuitable to produce a round Bolt of 2 Inches Diameter, and at the ſame time to look upon another ſquare Bar, that would produce a round Bolt of ½ an Inch Diameter, the Difference will appear very large; and the Iron that muſt be preſſed by beating the large Bolt from a ſquare Poſition into a round, is very much in Compariſion to the ſmall Bolt of 200 Foot long, which is the length of the ½ Inch Bolt, deem'd to be drawn by one Man and a Boy in one Day; and at the ſame time to take the 2 Inch Bolt of 50 Foot long, (which is the Length allowed to be a Day's Work for a Man and a Boy) and put them together, you muſt alſo allow the Difference in the Length to be Equivalent to the Difference that there is Oppoſite in the Bigneſs, and by Conſequence one to be equal to the other in the Labour, and if ſo all the other Sizes muſt be alſo equal to one another, which was to be demonſtrated.

I Proceed now to bring the neat Hundreds into Groſs Hundreds, the Common Weight that Smiths Work is meaſured by, for ſeting down the Value *per* Hundred in each ſize; and alſo ſhall inſtance the Waſte, which I allow to be $\frac{1}{20}$, of all Iron throughout.

The Quantity of Iron one Man and a Boy may Work in one Day.	The Quantity of Iron in Groſs Hundreds, that one Man and one Boy may Work in one Day.			The Charge of Coals and Workmanſhip for one Day's Work, to which I ſhall ſubjoin the Waſte, which is $\frac{1}{20}$ of all Iron.			The Quantity of the Waſte at 2 *d. per* Pound, if it may be thought Reaſonable at ſo high a Rate.		The Value of the Waſte at the aforeſaid Rate.		The Value of the Coals, Labour, and Waſte for one Day's Work.			The Value of the Coals, Labour, and Waſte in a Groſs Hundred Weight, or 112 pound of the ſeveral ſized Bolts as aforemention'd.		
l.	*c.*	*q.*	*l.*	*s.*	*d.*	*fa.*	*l.*		*s.*	*d.*	*s.*	*d.*	*fa.*	*s.*	*d.*	*f.*
136 8	1	0	24 [illegible]	4	1	2	6	½ $\frac{7}{10}$	1	1½+¼	5	3	0	4	3	1
162 8	1	1	22 8	4	3	3¾	8	½ 8	1	4¼	5	8	0¾		11	0
197 6	1	3	1 6	4	7	1	9	8	1	7	6	2	1	3	8	0
225	2	0	1	5	0	0	11	2	1	10½+¼	6	[illegible]	1	3	5	2
256 2	2	1	4 2	5	3	0	12	8	2	1½+¼	7	4	2	3	2	3
272 3	2	1	20 3	5	4	3	13	5	2	3	7	7	0	3	1	2
296	2	2	18	5	7	0½	14	¾	2	5½+¼	8	0	2	3	0	3
316	2	3	8	5	9	0½+¼	15	$\frac{1}{8}$	2	7½	8	4	2	2	11	3
334	2	3	26	5	10	0½	16	6	2	9	8	7	0	2	11	4
349	3	0	13	6	0	1¾	17	4	2	10¾	8	10	1	2	10	0
364	3	1	0	6	1	0¾	18	1	3	0	9	1	0	2	9	2
380	3	1	16	6	2	1½+¼	19	0	3	2	9	4	1	2	9	1
396	3	2	4	6	4	1½+¼	19	[illegible]	3	3½	9	7	3	2	9	0
412	3	2	20	6	5	3	20	[illegible]	3	5	9	10	3	2	8	3
427	3	3	7	6	7	1½	21	¼	3	6½	10	1	3	2	8	1
443	3	3	23	6	9	0	22	½ 8	3	8	10	5	0	2	7	3
459	4	0	11	6	10	2	22	8	3	9½+¼	10	8	0	2	7	1
475	4	0	27	7	0	1	23	[illegible]	3	11½	11	0	0	2	6	3
490	4	1	14	7	3	2½	24		4	1	11	4	2	2	6	1
506	4	1	26	7	5	3½+¼	25	$\frac{3}{10}$	4	2½	11	8	1	2	6	0
522 $\frac{15}{100}$	4	2	9 $\frac{85}{100}$	7	7	1½+¼	25	9	4	3¾	11	11	3	2	6	0

Now I am apt to believe that our Maſter Smiths will not only ſtickle, but alſo ſtand amaz'd to ſee theſe Calculations, believing that ſuch a Secret could never have been unravel'd and laid open; beſides, I am abſolutely perſwaded they will be ready to Vouch againſt it, as ſome Trades Men when they proteſt as they live they cannot Afford their Commodities at ſuch and ſuch Rates; indeed how the Maſter Smiths live, is as great a Secret as their Buſineſs; but you may ſoon ſee how their poor Journey-Men live, when they with their Families are near Starving.

However, to ſave them the Labour of too much Puzzling, I will in ſome Meaſure inſtance the Particulars, and then make a general Calculation of what the ſaid ſized Bolts may be worth *per* Hundred ready forged.

As to the Fireing, I am poſitive I have made a large Allowance, ſince the ſmalleſt Fire has near one Buſhel allowed, and half a Buſhel for one Day's Burning, or to Work 124 pound of Iron, and the large Fire has near 5 Buſhels and a half allowed for a Day's burning, or to Work one Hundred two Quarters and nine Pounds of Work.

As to the Workmen, they ſeldom allow them above 1 *s.* 6 *d. per* Day, from 4 a Clock in the Morning, till 9 a Clock at Night, except here and there a Leading Man perhaps may have 2 *s. per* Day. Only I had forgot, that in large Work, they allow them Small Bear, and a Cloth to wipe their Faces, and ſome ſmall intervening Circumſtances; there is alſo their Bellows, Anvil and Hammers; nay, the Shop too in Private Buſineſs, and for all which Wear and Tear, I ſhall allow them 2 *s. per* Hundred in every Article, but firſt ſhall Conſider what the Smith may pay for his Iron, which to be abſolute in will be a very hard Matter, ſince there be ſeveral Circumſtances that may alter that Caſe, as the Ability of the Party, the Advantage he has to obtain his Goods, and alſo the Market price; upon all which I ſhall be Content to ſet him a Round Price, that he may have no room to Complain of a Biaſs, which Price I ſhall allow in the general to be 18 *s. per* Hundred, and proceed to the Calculation.

The Diameter of the Bolts as they come from the Forge.	Price of the Iron as it may be afforded *per* Hundred, with Profit to the Smith, and in most Shapes.		The Charge of Coals, Workmanſhip and Waſte made in every Hundred Weight.			The 2 *s.* allowed in every Hundred for Tools and ſuch Utenſils as aforeſaid.	Total Price that the Smith may very well afford his Wrought Iron from the Forge, according to the Prices ſpecified, and may have a very ſufficient Gain in ſo doing.			
In.	*s.*	*d.*	*s.*	*d.*	*fa.*	*s.*	*l.*	*s.*	*d.*	*fa.*
0 1/2	18	8	4	3	1	2	1	4	11	0
0 5/8	18	8	3	11	1	2	1	4	7	0
0 3/4	18	8	3	8	0	2	1	4	4	0
0 7/8	18	8	3	5	2	2	1	4	1	2
1 0	18	8	3	2	3	2	1	3	10	3
1 1/16	18	8	3	1	2	2	1	3	9	2
1 1/8	18	8	3	0	3	2	1	3	8	3
1 3/16	18	8	2	11	3	2	1	3	7	3
1 1/4	18	8	2	11	0	2	1	3	7	0
1 5/16	18	8	2	10	0	2	1	3	6	0
1 3/8	18	8	2	9	2	2	1	3	5	2
1 7/16	18	8	2	9	1	2	1	3	5	1
1 1/2	18	8	2	9	0	2	1	3	5	0
1 9/16	18	8	2	8	3	2	1	3	4	3
1 5/8	18	8	2	8	2	2	1	3	4	2
1 11/16	18	8	2	8	1	2	1	3	4	1
1 3/4	18	8	2	7	3	2	1	3	3	3
1 13/16	18	8	2	7	1	2	1	3	3	1
1 7/8	18	8	2	6	3	2	1	3	2	3
1 15/16	18	8	2	6	1	2	1	3	2	1
2 0	18	8	2	6	0	2	1	3	2	0

I ſhall hereafter proceed to look into the Nature of working Old Iron, or what is generally term'd New working Iron; but ſhall firſt give my Opinion how ſuch Materials as Bolts and the like may be adjuſted as to the Goodneſs, before they be taken from the Forge; a Matter that has generally bred great Diſputes between the Smith and the Shipwright, tho' never fairly and regularly complied with by either, as I could take notice of. Nay, ſuch Trials have been variouſly managed at ſome Times, and in ſome Places the Smith has diſputed his Property of having the Bolts proved in the Shop, which Proof has been with a Stroke or two over the Anvil; at other times they have been carry'd out of the Shop, and proved over a Log of Wood, and at other times over the Shank of an Anchor, and the Performance or Force of Proving has been always as various, as the Places made uſe of to prove the ſame, ſince the Commanding Officer at ſometimes has ordered this Part wholly to be done by one Man, and then the Strength to prove an Inch Bolt was the ſame, as the Strength to prove a two Inch Bolt, altho' they in their Strength and Magnitude be very Various.

At another time this Part has been wholly neglected, when the Maſter Smith has been mighty, and would not ſuffer himſelf to be noſed, and brought to Acquieſce with an Inconveniency and Detriment to himſelf, that in his Contract and Bargain was never ſo much as mentioned; beſides, I could never perſwade my ſelf, but that all Proofs ought to be agreeable in every Reſpect to the ſtrain and uſe that the Material is to meet with, and if ſo, then ſtricking ſuch a Material thwart an Anvil of Iron, or a Block of Wood, is altogether contrary to the uſe of a Bolt, ſince the greateſt Strain that any Bolt bears is in driving of it, and in that faculty the Miſcarriage generally appears; for when once a Bolt is well drove and belayed, every part of the Wood aſſiſts and ſtrengthens the Bolt end-ways; and when any Ship grows ſo weak that the Parts work looſe, one part from the other, it's high time to lay that Ship by, and venture to Sea in her no longer.

Now in my Opinion if there is Neceſſity to prove ſuch Materials, which indeed I believe to be very proper, then let there be an Inſtrument provided in the Smith's Shop, that the Bolt may be placed in end-wiſe at near $\frac{1}{3}$ part of the Bolt in the hole, and $\frac{2}{3}$ parts out, and let ſuch an Inſtrument be fitted ſo Try, that the Bolt may be as cloſely Girt as it will be in the Augre hole it's deſigned to be drove into; then let there be 3 or 4 Strokes ſtruck on the head with a Hammer, (or Mall as its termed) that ſhould be ſizeable according to the bigneſs of the Bolt, and not allow that every Bolt, tho' ever ſo different in Size, ſhall be drove or ſtruck with a Hammer of equal Weight; which I take to be the Cauſe of Miſcarriage in that Reſpect as ſoon as any one Thing that makes it, and of which I ſhall conſider in the next place; only minding that the Charge of ſuch an Inſtrument as I have hinted to prove Bolts will be but little, and may be adjuſted as to the Charge of it in all Contracts, as alſo the Faſhion of the Proof, and how many Blows ſhall be ſtruck on the Head, with the Size of the Hammer; all which and ſuch Material Caſes, were they mention'd in all Contracts, it would often ſave ſuch Litigious Diſputes as happen between the Smith and the Artificer in Ship-building.

To go on Regularly, I ſhall now proceed to the Hammer, or as Shipwrights Term it, a Mall; which being a Matter highly neceſſary to conſider (tho' very hard to define) I ſhall endeavour to give as much Light into the Uſe of this Faculty as Poſſible. But by the way I ſhall give three or four neceſſary Cautions which muſt be minded in this Material Concern, ſince upon the well or ill Performance of the ſame (as in driving the Bolts) doth chiefly depend the Strength of the Ship.

The firſt Caution is, that ſuch Work ought to be done and performed by the beſt and niceſt Hands, that may exactly find, and after finding keep the Trim of the Bolt, or more plainly ſtrike the Bolt's Head direct or exactly on the Center, according to the Nature of the Hole.

The Mall appointed for that purpoſe ought to be as truly helv'd, and the Faces ſet as Parallel and kept as truly in ſuch a Poſition, as the Ax and Addice,

dice, or any other Inſtrument that's prepared for Edging of Planks, or to ſtrike in a perfect Prick or Center.

The Bolt ought to be exactly and very nicely wrought, not any thing bigger in one Place than in another.

The Material Hindrances in driving Bolts are three, *viz.* the Length, the Bigneſs, and Exceſs or Difference between the Diameter of the Augre and the Bolt.

The Length is a Hindrance, ſince the Stroke is applied on the Head, and communicated to the Point, where the greateſt Reſiſtance lyes, and therefore the longer any Bolt is, the more of the Power or Force of the ſtroke is loſt, before it arrives at the Point or Entrance of the Hole.

The Bigneſs is a Hinderance by Reaſon of its increaſing a Weight in Proportion to the Bigneſs, and muſt have an equal Force to that Weight, either in the one ſingle Hammer, or a certain number of Hammers or otherwiſe in the Strength of the Swing.

The Exceſs is a Hindrance, and the more by ſo much farther the Bolt is in the Hole, ſince 6 Inches Exceſs is more, nay twice as much as 3 Inches Exceſs; beſides its certain that all the Wood you diſplace by forcing a large Bolt into a ſmall hole, is not ſqueezed of each ſide the Bolt, but is alſo carryed before the point, and in ſome Meaſure looſely fills the hole again, and is Reſiſtance to the point of the Bolt.

The Size of the Mall may be in fault two ways; as firſt too big, and ſecondly too little; for if a ſmall Mall is uſed to drive large Bolts, and conſequently heavy ones, it will by its often Striking to little effect overheat and ſoften the Bolt, inſtead of advancing it and forcing the Motion.

Again, if a large Mall is applied to drive ſmall Bolts, it will rather ruck or double the Bolt than gradually advance it; tho' I have heard good Workmen diſpute for a ſmall ſmart Mall (as they Term it) that it will be more Efficacious in driving Bolts than a large Mall; indeed if a good well faſhion'd Mall may be term'd a Smart one, then I will acquieſce with the ſame, ſince its very ſeldom ſeen in Publick Buſineſs that ſuch Inſtruments are well or regularly perform'd, which I am apt to believe is the Cauſe of the Workman's Saying.

I ſhall now proceed to ſhew the Strength of Bolts one to another, which according to Duplicate proportion is according to the Square of the Diameter, ſo that as the Squares of the Diameters are one to another, ſo is the Strength of the Bolts one to another that are of equal length.

And to apply it I ſhall ſet down the Parts of 6 Ships, and from thence ſhew the Length, Diameter and Weight of the Iron ſuitable to faſten their ſeveral Parts, and ſhall alſo ſet down the Size of the Mall ſuitable and agreeable to force or drive a Bolt of any ſize.

Firſt I will ſet down the Diameter of the Bolts from ½ an Inch Diameter to 2 Inches Diameter, and ſquaring that Diameter ſhews the Proportion of ſtrength that one Bolt has to another Bolt.

Inches,

Inches. Diameters of the Bolts.	The Square of the Diameter, which as they are one to another, ſo is the Strength of the Bolts one to another with equal Length.
0 $\frac{1}{2}$	$\frac{25}{100}$
0 $\frac{5}{8}$	$\frac{39}{100}$
0 $\frac{3}{4}$	$\frac{57}{100}$
0 $\frac{7}{8}$	$\frac{78}{100}$
1 0	1
1 $\frac{1}{16}$	1 $\frac{13}{100}$
1 $\frac{1}{8}$	1 $\frac{26}{100}$
1 $\frac{3}{16}$	1 $\frac{42}{100}$
1 $\frac{1}{4}$	1 $\frac{56}{100}$
1 $\frac{5}{16}$	1 $\frac{76}{100}$
1 $\frac{3}{8}$	1 $\frac{91}{100}$
1 $\frac{7}{16}$	2 $\frac{8}{100}$
1 $\frac{1}{2}$	2 $\frac{25}{100}$
1 $\frac{9}{16}$	2 $\frac{45}{100}$
1 $\frac{5}{8}$	2 $\frac{66}{100}$
1 $\frac{11}{16}$	2 $\frac{85}{100}$
1 $\frac{3}{4}$	3 $\frac{6}{100}$
1 $\frac{13}{16}$	3 $\frac{30}{100}$
1 $\frac{7}{8}$	3 $\frac{56}{100}$
1 $\frac{15}{16}$	3 $\frac{78}{100}$
2 0	4

I ſhall imagine 6 Ships to be built, whoſe Parts are as follows:

	Inches		
First	Size	19	The Square of which Sides are	361
Second		17		269
Third		16		256
Fourth		14		196
Fifth		12		144
Sixth		10		100

The Strength of this Timber whoſe Sides are 19. 17. 16. 14. 12. 10. is one to another, as 361. 269. 256. 196. 144. and 100. as is here inſerted, provided the Lengths are all equal and a like.

The Bolts for theſe ſeveral Sizes as Cuſtom is	The Square of ſuch Diameters are	The Diameters Proportions are one to another as
1 $\frac{9}{16}$	2 $\frac{45}{100}$	Firſt to Second as 12 to 11.
1 $\frac{7}{16}$	2 $\frac{8}{100}$	Firſt to Third as 8 to 7.
1 $\frac{3}{8}$	1 $\frac{91}{100}$	Firſt to Fourth as 5 to 4.
1 $\frac{1}{4}$	1 $\frac{59}{100}$	Firſt to Fifth as 3 to 2
1 $\frac{1}{16}$	1 $\frac{13}{100}$	Firſt to Sixth as 7 to 4
0 $\frac{7}{8}$	0 $\frac{78}{100}$	

The Proportion of Strength one to another is	Which to anſwer the other ought to be ſomething otherwiſe than	The Difference ſhews what is between Cuſtome and my Demonſtrations.
Firſt to Second as 7 to 6	12 to 10	$\frac{2}{20}$
Firſt to Third as 9 to 7	8 to 6	$\frac{1}{4}$
Firſt to Fourth as 5 to 3	5 to 3	
Firſt to Fifth as 11 to 5	3 to	1 $\frac{38}{100}$
Firſt to Sixth as 5 to 1 $\frac{6}{10}$	7 to	$\frac{22}{100}$

The Weight of Iron to Oak, (which is the Principal Wood in Ship-building that is bolted) is as 35 to 4. So that it may be expected, if Iron and Oak be equally good, according to their different Species, their Strength may be agreeable to their Weight, and that if you imagine a certain Piece of Oak Timber 4 Foot long and 6 Inches Square, containing 1728 Inches, then a Piece of Iron containing 197 Inches will be equal in Weight to the 1728 Inches of Oak, and the Length of the Iron ſhall be 4 Foot, and the Square of the ſame 2 Inches, and ſome ſmall matter more. So that the Diameter or Side of the Square of Oak to Iron of equal Length is as 3 to 1 to make them of equal Weight, and equal Strength; but this is to be underſtood of Wood and Iron, when their Strain is equal; ſince its very apparent that they are not ſo in Ship work; ſince the Strain of the Timber is ſide-ways, and the Strain of the Iron is end-wiſe in moſt Places of the Ship; notwithſtanding this Property is Various; ſome Parts ſtraining abundantly more on the Bolt then others: as in hanging Knees, Standers, Foothook, and Top-Riders, where the tumbling of the Ship helps to cripple the Bolt; alſo in Breſt-hooks where the whole Weight of the Wood lyes upon the Bolt without any manner of Stop to aſſiſt. The Knee of the Head is alſo a very dangerous Paſſenger, and very aſſiſting towards cauſing Leakage in the Bows of a Ship, ſo that the Bolt's Diameter cannot be made general to the Bigneſs in every Part of the Ship, ſince the Strain and Faſtening doth Require to be ſo very various. However I ſhall give ſome Rules which way it may be in ſome meaſure adjuſted, only firſt I ſhall ſet down the Length of the aforeſaid Bolts, that will make their Strength equal one to another; as Firſt, in Caſe the Bolt of half an Inch Diameter was 1 Foot long, and the Bolt of 2 Inches Diameter was 1 Foot long, then the great Bolt would be 16 times as ſtrong as the ſmall Bolt; but if the great Bolt was two Foot long it would be but eight times as ſtrong, and if four Foot long but four times as ſtrong; if eight Foot long then but twice as ſtrong, but if 16 times as long then of equal Strength; ſo that if Bolts, or any other Matter of the like and equal Species, I ſay if the Length of ſuch Rods be one to another in proportion to the Squares of the Diameter, or Sides, their Strength will be alſo equal.

As for the Diameter of the Bolt to the Square of the Piece of Timber, or Side of any Piece to be faſtened, let it be as 1 to 12; in the largeſt Pieces, or in a Piece of 20 Inches, let the Diameter of the Bolt be one Inch and 68/100 Parts of an Inch; and for the Size downwards let it be thus, ſay, As the ſquare Root of the Side of one Piece is to the ſquare Root of the Side of another Piece, ſo is the Diameter of one Bolt, to the Diameter of the other Bolt, *Example*,

Side of the Piece in Inches.	Square Roots of the Sides.	
20	4 5/10	1 68/100
18	4 25/100	1 59/100
16	4	1 5/10
14	3 75/100	1 4/10
12	3 19/40	1 34/100
10	3 7/40	1 24/100
8	2 84/100	1 5/100
6	2 46/100	0 93/100
4	2	0 75/100
2	1 42/100	0 53/100

Diameter of each Bolt in Inches and Parts, which Rule will hold, and may be made general for all Parts that are bolted, and the extraordinary Strength the other way, ſhall be made up in Spacing the Bolts, or the Diſtance there is between Bolt and Bolt.

Diameter of the Bolts in Inches and Parts.	Length of each Bolt, which will make them of equal Strength to each reſpective Diameter, and ſuch Proportions will correſpond to any Equal, and a-like Rods of the ſame Species, as Wood to Wood, Iron to Iron, and the like.
0 1/2	1
0 5/8	1 56/100
0 3/4	2 11/40
0 7/8	3 1/10
1 0	4 0
1 1/16	4 1/2
1 1/8	5 0
1 3/16	5 7/10
1 1/4	6 7/20
1 5/16	7 0
1 3/8	7 13/20
1 7/16	8 3/10
1 1/2	9 0
1 9/16	9 8/10
1 5/8	10 6/10
1 11/16	11 4/10
1 3/4	12 2/10
1 13/16	13 2/10
1 7/8	14 2/10
1 15/16	15 1/10
2 0	16 0

Spacing of Bolts will require Variety of Conſiderations, according to the Uſe; but this will only happen in Parts that give Room for ſo various a Property, as in all Riders, Breaſt-hooks, Steps, Crutches, Knees, Scarphing of Beams, and the like; and firſt I ſhall begin with the Floor-Riders, which are Parts that lye croſs the lower and principal Floor of the Ship; for ſuch Parts have other Aſſiſtance of faſtening, beſides the Bolts, as generally a Pillar under the Beams, in the Middle of them, and if the Ship has Croſs Pillars, it will be very proper to continue them, ſo as to bring them on the Ends of the Floor-Riders, and if ſo, it may be allowed that the Middle and Ends of the Floor-Riders are materially confined by ſuch a Preſſure, but it cannot be abſolutely allowed to faſten them, and therefore ſome other Method muſt be thought of; for altho' they will not require ſuch a large Allowance of Bolts as ſome other Parts will, as long as a Ship is Water-born and afloat; notwithſtanding, if a Ship happens to lye on the Ground, eſpecially on one Side, then the Floor Riders have a principal Strain, as doth and will always appear if you happen to have the Tryal: I ſhall therefore, for ſuch Reaſons, allow a very ſufficient Quantity of Iron for ſuch Parts, and to be very well belayed by Clenching the Bolts.

I have before mention'd, that the Diameter of all Bolts ſhall be in Proportion to the Square of the Side of the Timber, or Part they are drove into, and to begin this Proportion I ſhall firſt ſet down two Dimenſions of Floor-Riders, one for a Ship of 48 Foot broad, and one for a Ship of 25 Foot broad.

The

The Dimenſions of a Ship's Floor-Rider, of 48 Foot broad.

	Ft.	In.
Length of the Rider	24	0
Breadth	1	8 $\frac{1}{2}$
Depth	1	4 $\frac{1}{2}$
Square of the Depth and Breadth, is	1	5 $\frac{8}{10}$
Bigneſs of the Bolt	0	1 $\frac{9}{16}$
Length in the Medium	3	7
Square-Root of the Side of the Piece	0	4 $\frac{21}{100}$
Square-Root of the Bolts Diameter is, in 16 Parts of an Inch	0	1 $\frac{5}{16}$

The Dimenſions of a Ship's Floor-Rider of 25 Foot broad.

	Ft.	In.
Length of the Rider	13	6
Breadth	0	11 $\frac{8}{10}$
Depth	0	7 $\frac{8}{10}$
Square of the Breadth and Depth, is	0	9 $\frac{6}{10}$
Bigneſs of the Bolt	0	0 $\frac{7}{8}$
Length in the Medium	1	9
Square-Root of the Side of the Piece	0	3 $\frac{1}{10}$
Square-Root of the Bolts Diameter is 100 Parts of an Inch	0	$\frac{37}{100}$

The Proportion of their ſeveral Parts are one to another as follows.

The great Ship's Rider's Length is to the Length of the ſmall Ship's Rider, as	16 to 9
Their Breadths are one to another, as	16 to 8 $\frac{8}{10}$
Their Depths are one to another, as	17 to 8
Square of their Breadths and Depths are one to another, as	45 to 23
Lengths of their Bolts are one to another, as	39 to 19
Bigneſs of the Bolts are one to another, as	25 to 14

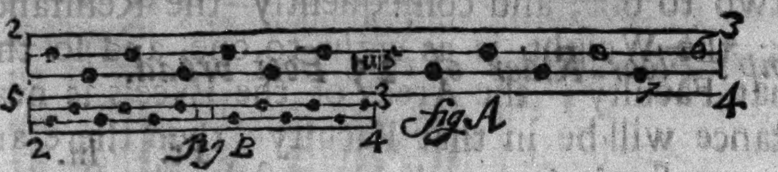
Theſe Proportions Lip about the Proportion of as 2 to 1, as Fairies dance about a Circle; but whether the Proportion of Strength will be found ſo in every Particular I ſhall conſider of it as follows.

Firſt, The Square of their Sides is as 4 to 1; and, according to Sir *William Petty* of *Duplicate Proportion*, their Strength may be expected to be, provided they were of equal Length; but ſince their Lengths are as 2 to 1, the Strength of the long Piece will be diminiſhed half, and then according to the Rule their Strength will be as 2 to 1. And for a more clear Illuſtration of the Work I have thought fit to produce one Query, and ſhall, as Opportunity preſents, proceed to Tryals, and make it fully obvious.

Mr. *Evilyn* in *Sylva*, tells us, that the Royal Society in making Tryals of this Nature found, that a Piece of Fir 2 Foot long, and one Inch ſquare, weighed 8 Ounces $\frac{1}{16}$, and was broke with 200 Weight; another Piece of Fir half an Inch ſquare, and two Foot long, weighed one Ounce, and was broke with 33 Pound weight; ſo that from theſe and ſome other Experiments at that time made, and there inſtanced, it appears that if Pieces equally long be augmented as 2 to 1 in Bigneſs, they ſhall be ſtrong as 8 to 1, and then theſe Riders muſt be in ſtrength as 4 to 1: But waving this at preſent I ſhall conſider them from a duplicate Proportion, till I can inſtance a more familiar Rule to adjuſt that Part.

Then to proceed, I allow that theſe two Riders mention'd ſhall be in Strength, (provided the Timber is equal in Goodneſs) as two to one, that is, the long and large Rider is twice as ſtrong as the ſmall ſhort Rider, the Workmanſhip as Notching, and Ax Chops I allow agreeable to the ſame.

The Dimenſions of a Rider, ſuitable to the great Ship, will be 24 Foot long, or half her Breadth and Bigneſs, 1 Foot 8 Inches, and 1 Foot 6 Inches, the Square of which is 1 Foot 6 Inches $\frac{12}{20}$; then the Dimenſions of a Rider ſuitable for the ſmall Ship will be 12 Foot long, and Bigneſs one way 10 Inches, and the other way 9 Inches, the Square of which is 9 Inches and $\frac{12}{40}$, which Dimenſions will make them as 2 to 1 in Strength, according to duplicate Proportion; but the Weight of the Ships are as 8 to 1, and conſequently the Strain and Strength requiſite in the Parts may be ſo too; however, I ſhall at preſent ſuit the Bolts according to our preſent Cuſtom, and refer the other Part until nice Trials be made.



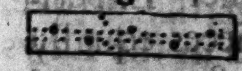
In the Figures *A* and *B* you may obſerve the Method I thought proper to deſcribe for Bolting ſuch Parts, *A* being a Rider of 24 Foot long, and of Subſtance ſuitable to that Length as aforeſaid; and *B* is a Rider of 12 Foot long, and of Subſtance ſuitable to *A*: The Parallelogram 3, 4, 2, 5, ſhews the Baſis of each, where you may obſerve the prick'd Lines are the Intervals, as I judge to be moſt proper for the Bolts to be put, being much better to place them there than in the Middle of the Pieces, not only for preſerving the Rider from Rifting or Splitting, by having all the whole Number of Bolts in one Row, but it alſo binds the Rider down much firmer, as well the Edges as the middle Part; the Method for ſetting of the End Hole is to take the half Breadth of the Rider and ſet off from the Ends; then taking the whole Breadth and ſet off from the End Hole croſs-wiſe ſucceſſively to the Middle of the Rider, where there will be a Pillar which will bind and faſten, and not only ſo, but that theſe Riders are placed over the lower Foot-hooks, that there can be no Bolt in the Middle of the ſame.

The Number of Bolts are equal in each, which is 12; the Length is as 2 to 1, and ſo ought the Bigneſs to be; then the biggeſt Bolt being 1 Inch $\frac{2}{16}$, the ſmall Bolts muſt be $\frac{25}{32}$, or $\frac{3}{4}$ of an Inch, and $\frac{1}{32}$ parts of an Inch, that is $\frac{3}{32}$ parts of an Inch leſs than the Cuſtom.

Then to ſhew the Weight of Iron to the Weight of Wood, allowing that one Foot of Oak, every way Die ſquare, (neither over dry nor over wet, but according to our common Cuſtom of Working the Allowance of Heart to Sap) weighs 56 Pound, and Iron to Oak is as 7645 is to 870.

The Length of the large Rider being 24 Foot, and the Square of the Sides is 18 Inches $\frac{12}{20}$, and contains 59 Foot and a half of ſolid Timber, weighing *29 c. 2 q. 14 l.* the Number of the Bolts being 12, each 3 Foot 7 Inches long, and 1 Inch $\frac{9}{16}$ Diameter, containing 2 *c.* 1 *q.* 27 *l.* $\frac{1}{2}$, ſo that the Weight of Iron to the Weight of Wood in this Piece, is as 4 to 47 $\frac{1}{4}$, or near as 1 to 12; and for the Eaſe of Calculating, I ſhall allow that the Weight of Wood to the Weight of Iron in all Riders ſhall be as 12 to 1, including Foot-hook Riders, Breaſt-hooks, and Steps, the Faſhion of ſetting off the Bolts will be alſo proper in any Rider, Breaſt-hook, Step, or Knees that is above 6 Inches thick, and in all Pieces under 6 Inches thick, to ſet off the Bolts as in the Figure C, dividing the Baſis into 7 Parts, letting 3 Parts of 7 be of each Side, and two Parts in the Middle to produce Lines for the Centers of the Bolts, as the pricked Lines; the Content of the ſmall Rider is to the large one as 1 to 8, and and ſo are the Bolts, and will bear the ſame Proportion in every reſpect; I ſhall therefore in the next Place conſider the Weight of the Mall or Hammer, ſuitable to drive the Bolts, before I ſhew the Method of Bolting the Knees and Standers.

Fig. C



The Weight of the large Bider Bolts is 23 Pound $\frac{1}{4}$ each, and the ſmall Rider Bolts being $\frac{1}{8}$ of 23 Pound $\frac{1}{4}$ is 2 Pound $\frac{9}{10}$ of a Pound, or near three

Pound; according to the Laws of Motion the greateſt Reſt has not Force to reſiſt the ſmalleſt Motion, and therefore the ſmalleſt Mall, when accelerated by the Force of a Man's Arm, will be able to advance the biggeſt and largeſt Bolt, as long as it continues to be no more than a Bolt, or at leaſt-wiſe out of the Hole; neither am I conſidering things to an extream, or talking of Things beyond a common Uſe, but of the largeſt Bolt as I have in this Work ſpecified, and alſo of the ſmalleſt Mall that is in common Uſe with Ship-builders.

I have before mentioned what is the Cauſe of Reſiſtance in Bolts, *viz.* the Length, Bigneſs, and Exceſs, or the Difference between the Augre and the Bolt, ſo that the Difference in the Reſiſtance of theſe two Bolts is threefold, ſince the Lengths are as two to one, and conſequently the Reſiſtance muſt be ſo too in that Faculty; the Weight is as eight to one, and ſo the Reſiſtance muſt be allowed in that Faculty; the Areas of the Exceſs is near as four to one, and ſo the Reſiſtance will be in that Faculty; then there are three Fractions given to produce one ſingle One, which muſt be the Proportion of the Reſiſtance.

The Length being $\frac{1}{2}$, the Weight $\frac{1}{8}$, and Difference of Exceſs $\frac{1}{4}$, which × is $\frac{1}{64}$, ſo that the Reſiſtance of the Bolts are as 64 to 1, and will require a Force equal to that Proportion to make the Motion of the two Bolts equal one to another, which Force muſt be made up either in the Strength of the Man, Weight of the Mall, or Number of Malls, but the Number of Malls, in my Opinion, will be moſt ſuitable to the Purpoſe, which I ſhall demonſtrate as follows.

Firſt then, I have obſerved, and alſo have had it told me by the moſt experienced Workmen in Ship-building, that a Pen-Mall of 6 Pound, or 6 Pound and a half Weight, is as Sizeable to the Strength of a Middling Man as any Size whatever, which Size I ſhall allow to the ſmalleſt Bolt, and that to the Weight of the Bolt will be as two to one; now was you to uſe a Mall of double the Weight of the largeſt Bolt it would be 46 Pound and a half, and perhaps it might be expected that this Mall would force the great Bolt as faſt as the little Mall will force the little Bolt, which undeniably will not be in ſundry Caſes. As Firſt,

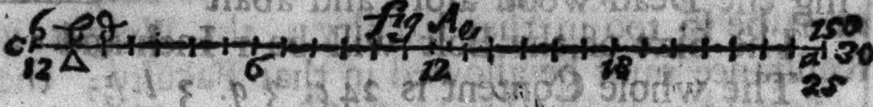
I ſhall conſider the Strength of a Man, which is our common Engine that forces the Bolt with a Hammer, it's found that 14 Men, one with another, do weigh 20 Hundred, which is 143 Pound to every Man; it being alſo obſerveable that a Man will lift and carry, ſo as to continue it for a Time, a Weight equal to his own Body; from which I ſhall allow the Force of a Middling Man to be equal to 150 Pound, this 150 Pound as a Power forcing a Hammer of 6 Pound, is as 25 to 1, but if 150 Pound, as a Power, uſe a Hammer of 46 Pound and a half Weight, it's but as 29 to 9, or little more than as 3 to 1, and ſo much the Power is Increaſed, tho the Weight is Decreaſed, and ſo I am to conſider what Number of Men, with equal Malls and equal Strength, will advance and make the Motion of thoſe two Bolts equal.

The Reſiſtance you ſee is as 64 to 1, and therefore if 64 Men, with equal Strength and equal Malls, were to ſtrike their Strokes no quicker on the ſame than a Single Man, they would advance the ſmall Bolt (much more the large Bolt) no faſter than a Single Man would do, as long as he could hold it, ſo that the Motion muſt be accelerated by the Quickneſs of the Stroke, by making of it almoſt a conſtant and uniform Motion, as I find in the Laws of Motion, written by Sir *Iſaac Newton.*

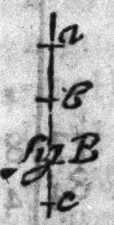
That the Product of the Duration of all uniform Motions multiplied by the Force which began the Motion, is proportionable to the Product made by the Parts or Line of Motion × by the Maſs or Quantity of Matter in the moving Body; as for Inſtance, Let it be ſuppoſed that by one Stroke the Bolt ſhall advance four Quarters, or four half Quarters, or Seconds, or the like, and that by the Quickneſs of the Stroke half the ſaid Motion ſhall be continu'd at Striking the ſecond Stroke, then multiplying 2 by 4 it's 8, ſo that the firſt and ſecond Stroke advances 12, and continuing the Motion 4 till the third Stroke ſtrikes, which 4 × by 4 is 16; ſo that the firſt, ſecond, and third Strokes ſhall advance the Bolt 28, and continue 14, till the fourth Hammer ſtrikes, then × 14 by 4, its 56; ſo that four equal Hammers or Malls, with equal Force, and the four Strokes made in equal Time, to what the one Stroke is made on the ſmall Bolt, will advance the large Bolt near as faſt as the ſmall one, or within $\frac{1}{7}$ of the Celerity, which Faculty may be experimentally made in driving large Bolts with any Number of Hammers.

However, believing (and alſo by Cuſtom obſerving) that there are larger Hammers, I ſhall ſuit a Proportion for the Weight of the Hammer or Mall from the Cube of the Weight of the Bolt.

Weight of the Bolt. *l.*	Cube Root of the Weight of the Bolt.	The Weight of the Malls agreeable to the Weight of each Bolt. *l.*
23	2 $\frac{17}{20}$	12
21	2 $\frac{15}{20}$	11 $\frac{6}{10}$
19	2 $\frac{13}{20}$	11 $\frac{2}{10}$
16	2 $\frac{5}{20}$	10 $\frac{6}{10}$
14	2 $\frac{4}{20}$	10 $\frac{2}{10}$
12	2 $\frac{3}{10}$	9 $\frac{7}{10}$
10	2 $\frac{2}{10}$	9 $\frac{3}{10}$
8	2	8 $\frac{1}{2}$
7	1 $\frac{92}{180}$	8
6	1 $\frac{91}{100}$	7 $\frac{6}{10}$
5	1 $\frac{7}{10}$	7 $\frac{3}{10}$
4	1 $\frac{6}{10}$	6 $\frac{3}{4}$
3	1 $\frac{45}{100}$	6
2	1 $\frac{26}{100}$	5 $\frac{3}{10}$
1	1	4 $\frac{1}{4}$



I ſhall conſider ſomething farther of the Efficacy in Sizeing the Mall; for ſuppoſing that the Figure *A* was a Leaver, the Power being at *a*, the Weight at *c*, and the Prop, or Fulcimen at *b*, I ſuppoſe that the Weight being 6, the Power is 150, which is as 1 to 25, for ſo the Power is increaſed by having *b a* 25 times *c b*; now was you to place 12 Pound at *c*, inſtead of 6, you muſt have 300 Pound at *a* inſtead of 150, to raiſe the Weight with the ſame Facility as you did before, and by conſequence either the Prop will be removed to *d*, or the Power to *e*, and that the Proportion of the Power to the Weight will be but as 12 to 1; ſo that was a Man to uſe a 12 Pound Mall, and a 6 Pound Mall, he would have but half the Strength proportionably in uſing the great one, to what he would have in uſing the ſmall one, ſince half his Strength would be reduced in uſing the great Mall, by its double Weight; but however, the Weights of the Malls would be advanced as 2 to 1, which would be advantagious in driving Bolts downwards, as may be inferred from the Acceleration of falling Bodies, ſince the Velocity of falling Bodies is double to that which in the ſame time would have deſcribed the Space fallen by an equal Motion, and that the Motion of fallen Bodies are increaſed according to the Square Root of the Times wherein they fall, as in the Figure *B*, ſuppoſing a Weight to fall from *a* towards *c*, if the ſaid Weight falls two Foot, or from *a* to *b* in one Minute, then in two Minutes it ſhall fall four Foot, or from *b* to *c*, and ſo on in Proportion as Roots are of the Square of the Time falling to the Diſtance falled, and therefore the double Weight will increaſe the Motion of the Mall, and accelerate the Percuſſion, according as the Weight of one Mall is to the Weight of the other.



But on the other Hand, I cannot really commend a heavy Mall for driving Bolts either upwards or by an equal and parallel Height of a Man's Elbow, ſince the Mall muſt be raiſed by the Man's Strength, which makes me really acquieſce with the Workman's ſmall or middling Mall judging it to be more Smart and Serviceable than an over-large one.

The famous *Galileus* was the firſt that proved the Line of a Bullet to be in the Curve of a Parabola, abſtracting from the Line of Impuſe, and the Reſiſtance of the Medium; which Line of Impulſe, in our preſent Matter, muſt be the Line of Strength in a Man's Arm, in raiſing the Mall, or Hammer, to the greateſt Height, ſo that this Strength requiſite to raiſe the Mall, and the Reſiſtance of the Air (which is ſomething) muſt be ſubſtracted from the Man's Length in Driving, or Striking any thing above the Center of his Strength; but ſuſpending this Diſcourſe, which would be vaſtly entenſive if every little Faculty was conſidered on the Subject, I ſhall proceed to conſider the Quantity and Quality of the Bolts, and other Iron work that will be required to moderately, but ſufficiently faſten a Ship of any Magnitude, alſo the Length, Number, and Size of the ſame in every individual Part.

In the Proſecution of which I ſhall firſt inſtance every Particular Part that will be required to be applied in a Ship of the largeſt Size, and alſo in one of the ſmalleſt Size, and obtain a ſuitable Quantity of Iron-work for any other Ship from thence.

I begin with a Calculation for the Iron-work for a Ship of 1700 Tuns.

	Cont. in Ft.	Wt. of 1 Ft.
She muſt have 50 Floor Timbers, bolted with 20 Bolts of 5 Foot 7 Inches long, and 30 of 10 Foot; which will allow for Bolting the Dead-wood afore and abaſt —— —— ——		l.
The Size of the Bolt will be 1 Inch and ^{9}. ——	427	6 $\frac{1}{2}$
The whole Content is 24 *c.* 3 *q.* 3 *l.* $\frac{1}{2}$		
She muſt have Floor-Rider Bolts 108, at 3 Ft. 7 In. Length in the Medium; and Foot-hook-Rider Bolts 126, of three Foot long; Cratches 2; Bolts 24, 4 Foot and a half each; Mizen Step half that Quantity; Fore Step 16 Bolts, 4 Foot each; Breaſt-hooks 10, each 3 Foot and a half long; Tranſum Knees, in each 14 Bolts at 2 Foot 8 In. in a Bolt. —— —— ——	2134	6 $\frac{1}{2}$
Size of the Bolt 1 Inch $\frac{6}{16}$. The whole Content is 6 *tuns* 3 *c.* 3 *q.* 16 *l.* Rings for belaying 426 *l.* And Forelocks 227 in this Article.		
Orlop Knees 24, and Standers 24; Bolts in each Arm 3, which will be 144 Bolts thro' the Side, 3 Foot each, and 144 thro' the Beams, of 2 Ft. each. —— —— —— ——	720	6 $\frac{1}{2}$
Gun-Deck Knees, Lodging 52, and Hanging 52, allowing 7 Bolts to each through the Side, and 3 thro' the Beams, which is 364 Bolts through the Side of three Foot and a half each in the Medium, and Bolts 156 fore and aft, of 3 Foot and a half long in the Medium; and in this Calculation I allow for Bolting the thick Clamp abaft, and that the Knees ſhall be ſided $_{7}$ of what the Beams are the Moulding-way.	1820	6 $\frac{1}{2}$
Stander-Bolts 60 of 2 Ft. and 60 of 3 Ft. $\frac{1}{4}$. —— ——	340	6 $\frac{1}{2}$
Ring-Bolts and Eye-bolts, with 10 Laſhing-Bolts for the Ports. -	479	6 $\frac{1}{3}$
Size of the Bolt is 1 Inch $\frac{9}{16}$. The whole Content is 8 *t.* 3 *c.* 0 *q.* 22 *l.* $\frac{1}{4}$. Rings 578 $\frac{1}{2}$. Forelocks 289 $\frac{1}{4}$.		
Stopper Bolts 14, 5 Ft. and a half each, containing 620 Pound.	77	8 $\frac{1}{11}$
Laſhing Bolts for Muzzles of Guns 28, 3 Ft. each, containing 346 Pound $\frac{3}{4}$. —— —— —— ——	84	4 $\frac{9}{64}$

Port-hinges 50 Pound the Pair, is 1400 Pound.

Port-hooks ——	519 $\frac{3}{4}$.
Inſide Shackles, and Bolts in the Hinges	261
Outſide Shackles —— ——	84
	2264 $\frac{3}{4}$
The whole Content is	1 *t.* 2 *c.* 1 *q.* 34 *l.*
Rings for Stopper-Bolts —— ——	16 $\frac{1}{2}$
For Laſhing Bolts —— ——	12
For Port-hooks —— ——	24
For Shackles —— ——	28
Forelocks —— —— ——	14

For the Dimenſions of the Port-hinges, Hooks, Bolts, and Shackles, compute the Weight of the Port; allowing that this Part

is

Content in Ft. | Weight of 1 Ft.

is 3 Ft. 7 In. $\frac{1}{2}$, and 2 Foot 8 In. and a half; the Square of the ſame is 3 Ft. 1 In. and a half, and to be 2 In. and a half Plank, lined with Elm Board of 1 Inch thick; ſo that the Weight of the Oak will be found to be 112 Pound, and the Elm 28 Pound, the Nails will be found by × for every 3 Inches the Port is each way 1, which in this is 14 by 11, and that is 154, which will alſo give an Allowance for broken and defective Nails; the ſizeable Nail for this Port will be 2 Inches and a half long, a thouſand weighing 22 Pound; then the Weight of Nails to the Weight of Wood will be as 2 to 90, the Weight of Nails being 3 *l.* $\frac{4}{15}$.

I allow the Length of a Port Hinge to be as much as the Clear of the Port-hole, and each Hinge to be equal to as many Inch-Bolts as the Port is Feet Fore and Aft, which in this is 3 and a half, and 1 Foot of an Inch Bolt being 2 *l.* 10 Ounces and a half, the Hinges to each Port will be 50 Pound, which to the Wood is as 1 to 3, then all the Hinges to 28 Ports will be 1400.

Port-hooks of 1 Inch $\frac{1}{4}$ Bolt each 23 Inches long, and being 56 of them is 22 Foot. at 4 *l.* 2 *Ounces* and a half to a Foot is 519 Pound $\frac{3}{4}$.

Shackles 2, of Inch to each Port, the Rings 12 Inches Circumference is 16 Inches in all; Bolt in the Hinges 5 Inches each; Shackles and Bolts to each Port 3 Ft. and a half by 28 is 98 Ft. 2 Pound 10 Ounces $\frac{1}{2}$ to each Port.

Content of Shackles 261 Pound.

The outſide Shackle a $\frac{1}{8}$ of an Inch Bolt, the Ring, and Bolt, and Eye, 1 Ft. 6 In. it's 42 Ft. by 2 *l.*

Content 84 Pound.

For Scarphing of 20 Beams, with a 12 Ft. Scarph in the Me- 260 | 2
dium, 8 Bolts in each, 1 Ft. 8 In. long, is 13 Ft. by 20; Size of
the Bolt 1 Inch $\frac{1}{8}$.
Content ——— 878 *l.* Rings 50 Pound.

For the Bitts and Spurs 8 Bolts, of 3 Foot and a half each: 28 | 3 $\frac{6}{16}$
Content 94 *l.* Size 1 $\frac{1}{8}$, and 12 Bolts of 3 Foot long each, and 12
of 2 $\frac{1}{2}$, Size 1 $\frac{1}{4}$; Hooks of the ſame Size 24 Ft. 90 | 4 $\frac{9}{64}$
Total Content of theſe Bolts, is 374 $\frac{3}{4}$, Rings 8 $\frac{1}{2}$.

Ring-bolts and Eye-bolts for the Gun-room Ports 16, of 3 Ft.
8 In. long each the Ring-bolts, and 2 Ft. 2 In. the Eye-bolts. 46 $\frac{2}{3}$ | 4 $\frac{9}{16}$
Content is 193 *l.* Rings 27 *l.* Forlock 1 *l.*

	c.
Hinges 8, at 40 *l.* each Pair is — —	1120
Port-hooks, Size 1 $\frac{1}{8}$, 10 Ft — —	333 $\frac{3}{4}$
Shackles 8, of 2 *l.* and a half each, — —	220

Partner-bolts Main, Fore, and Bowſprit.
Main-Partners 16 Bolts, of 2 Ft. 3 In. each. Size 1 $\frac{1}{8}$. 36
Fore Partners 16 Bolts of 2 Ft. 2 In. each, is 34 $\frac{2}{3}$
Size 1 $\frac{1}{16}$ Augre. —— Content both 224 *l.*
Bowſprit Partners 12 Bolts. — — — 23
by 1 $\frac{1}{16}$ Augre. —— Content 69 *l.* in all 293 *l.*

Rings — 11 $\frac{3}{4}$ *l.*

The Total Sum to this Place is,

	t.	c.	q.	l.
For the Floor-Timbers, Floor-Riders, Crutches, Steps, and Breaſt-hooks, and Tranſum-Knees.	1	4	3	3
The Total is — — — —	6	3	3	16
Orlop and Gun-deck Knees, Standers, and Port-bolts. — — — —	8 *t.*	3 *c.*	0 *q.*	22 *l.*

	t.	c.	q.	l.
Stopper-bolts, Muzzle-bolts, Port-hinges, *&c.* —	1	2	1	24
Scarphing-beams, Bitts, Gunroom-ports, and Partners	0	17	1	8
Total is —	17	11	2	17

And now I ſhall proceed to the Middle Deck, where the Size of the Bolt, for the Knees, Standers, and Ports, is 1 Inch $\frac{1}{4}$, which by the Square of their Diameter is $\frac{400}{625}$, or $\frac{9}{14}$, of the Lower-Deck; the Length of the Bolts is, $\frac{6}{8}$ × by $\frac{9}{14}$ is $\frac{54}{112}$, and ſo the Knees, Standers and Port-bolts are one to another.

	t.	c.	q.	l.
The Gun-Deck Knees being	3	13	3	16
The Middle-Deck Knees to them are as 54 to 112, which is —	1	15	2	0
Gun-Deck Stander-Bolts, are	1	0	0	0

The Middle-Deck Standers are 7 pair, ſo that the Proportion is as 378 to 1120, or as 3 to 10, which is 0 *t.* 6 *c.* 0 *q.* 8 *l.* Port-bolts, with 10 Laſhing-bolts between, very proper to be alſo on the Middle Deck

	t.	c.	q.	l.
The Weight of the Lower-Deck, is	1	7	3	3
Then as 54 to 112. the Content is	0	12	1	12
Laſhing-bolts for the Muzzles — ×				

For the Port-hinges, Hooks, and Shackles, the Proportion ſhall be as the Port is deep and wide; for the Hinges and the Hooks ſhall be agreeable thereto

Lower Ports, are $\frac{2}{3}\ \frac{7\frac{1}{2}}{8\frac{1}{2}}$ Middle Ports, are $\frac{3}{2}\ \frac{2}{7}$

The Fractions are $\frac{7}{8}$, and $\frac{15}{19}$ × $\frac{136}{152}$ Then the Weight of the Lower-Hinges being 50 pound,

The Middle-Hinges will be 41 $\frac{1}{2}$

Content in pounds, is 1152 0

Port-hooks of Inch Bolt the Fraction is $\frac{4}{5}$ Length of the Sides, is as 6 to 8 × $\frac{4}{5}$ by $\frac{6}{8}$, it's $\frac{24}{40}$.

Weight of the Lower-hooks, is 519 $\frac{3}{4}$.

Dᵒ of the Middle-hooks — 310

Put two Shackles and two Bolts to each Port of $\frac{5}{8}$ of an Inch, Bolt-ring of the Shackle, 12 Inches Circumference, Eye 6, Bolt 12, in all is two Foot and a half to each Port, by 28 is 70 Foot, or 73 Pound.

Two Breaſt-hooks, one under the Hawſe, and one under the Middle-Deck, 20 Bolts, Size 1 $\frac{1}{2}$ Diameter, being three Foot and a half long each, is 70 Foot, by ſix Pound is 420 pound.

For Scarphing of Beams 20, at 10 Foot Scarph, 7 Bolts in each Scarph of 1 Ft. 3 In. long, being 8 Ft. 9 In. in each Beam, is 175 Ft. of Inch Bolt, or 465 pound

Partner Bolts, and Comming Carlings by an Inch Augre, and Capſtand, *&c.* 90 Foot, or 240 Pound.

To Sum up,

	l.	
Port-hinges, *&c.*	1152	0
Hooks —	310	0
Shackles —	73	
Breaſt-hooks 2 —	420	
Beams —	465	
Partners —	240	
Total —	2660	

	t.	c.	q.	l.
For Knees —	1	15	2	0
Standers —	0	6	0	8
Port-bolts —	0	12	1	12
Other Eyes —	1	3	3	0
Total —	3	17	2	20

		l.		l.
Rings	Knees of the Deck	179		50
	Standers	$23\frac{1}{4}$		3
	Port-bolts	28	Forlocks	14
	Shackles	12		6
	Breaſt-hooks	15		
	Scarphing-beams	28	Total	73
	Total	$285\frac{1}{4}$		

Total for the Middle-Deck's faſtening.

The Calculation for the Upper-Deck is as follows.

For Knee-bolts, Size is $1\frac{1}{8}$; the Number is the ſame with the Middle-Deck Knee-bolts; length of the Middle-Deck Knee-bolts to theſe are as 4 to 5; Size as 8 to 9, × $\frac{8}{9}$ by $\frac{4}{5}$ it's $\frac{32}{45}$; then the Weight of the Bolts is as 32 to 45, which is 1 *t.* 5 *c.* 1 *q.* 0 *l*

Standers 3 pair, the Number is as 3 to 7, × $\frac{3}{7}$ by $\frac{32}{45}$ it's $\frac{96}{315}$ Weight of the Stander-bolts is as 96 to 180, which is as 0 *t.* 3 *c.* 1 *q.* 1 *l.*

For Port-bolts, the Length is as 4 to 5, and Bigneſs as 8 to 9; the Number the ſame with the Middle-Deck; the Proportion is to the Middle-Deck as 32 to 45, and ſo is the Weight, which is 0 *t.* 8 *c.* 3 *q.* 6 *l.*

		Ft.	In.		Ft.	In.
For Port-hinges	Port Fore and Aft	2	9	Middle Port	3	2
	Up and Down	2	6		2	7

The Fractions are $\frac{7}{8}$ by $\frac{31}{32}$, which is × $\frac{217}{256}$, then the Weight of the Hinges is

Hooks Length to each Port is 1 Ft. 6 In. that is 42 Foot by $\frac{7}{8}$, It's 85 pound.

Middle-Deck —— $41\frac{1}{2}$ each.
Upper is —— $35\frac{1}{2}$ each.
The Weight of the whole Number is —— 992 pound.

There are 2 Shackles to each Port, of one pound and a half, each is 42 *l.* one Breaſt-hook with 10 Bolts, by $1\frac{1}{4}$, two Foot and a half long each, which is 103 *l.* and a half.

For Scarphing 20 Beams at nine Foot, Scarph-bolts ſize $\frac{7}{8}$ of an Inch, it's 284 pound.

Ring-bolts, for Laſhings for the Long-boat 20, of $1\frac{3}{16}$, and three Foot long each, is 60 Foot, × by 3 - 11 $\frac{3}{4}$, the Weight of 1 Ft. of Bolt of that Length, it's 224 pound.

Comming Carlings Bolts 24, of 18 Inches long, × by the Size of a $\frac{7}{8}$ Inch-bolt, and Partner-bolts for Maſts and Capſtands 18 of 15 Inches long is 22 Foot and a half, it's 45 pound and a half.

To Sum up

	l.
Port-hinges	992
Hooks	85
Shackles	$103\frac{1}{2}$
Beams	284
Laſhing-bolts	224
Partners and Carlings	$45\frac{1}{2}$
Total —	1734

	t.	c.	q.	l.
Knees	1	5	1	0
Standers	0	3	1	1
Port bolts	0	8	3	6
Ditto	0	15	1	7
Total —	2	12	2	14

		l.		*l.*
Rings	For Knee-bolts	129	Forlocks	37
	Standers	$7\frac{1}{2}$		
	Port-bolts	$20\frac{1}{2}$		
	Breſt Hook	$4\frac{1}{2}$		$10\frac{1}{4}$
	For Scarphing Beams	23		
	Laſhing Bolts	$7\frac{1}{2}$		$3\frac{1}{2}$
	Total for the Upper Decks faſtening			

The Calculation for the Quarter-Deck and Forecaſtle, is as follows,

There will be forty Beams, and therefore I allow of forty Knees, that every Beam may be ſingle Kneed, and ſome double Kneed, ſix Bolts to each Knee by a Bolt of $\frac{7}{8}$ Inch Diameter, and 1 Foot 3 Inches Length, they Contain 609 Pound.

Port-bolts for 14 Ports, 32 Ring-bolts and 32 Eye-bolts, 2 Ring-bolts and 2 Eye-bolts to be 7 Foot long, and bigneſs $\frac{7}{8}$ of an Inch Diameter, is 138 Pound.

Iron Work for 6 Ports, 86 Pound.

Poop-beams 16 Knees, 16 Bolts of $\frac{5}{8}$ Diameter, 6 Bolts in each of 12 Inches, is 96 Foot, or 138 Pound.

Strings in the Waſte Inch Bolt 40 in Number, 9 Inches long, is 30 Foot, or 84 Pound $\frac{1}{2}$.

Strings in the Great Cabbin-bolts 28 by $1\frac{1}{8}$ 12 Inches long, is 28 Foot, containing 94 Pound $\frac{1}{2}$.

Cat-heads 10 Bolts, 2 Foot long each by $1\frac{1}{4}$, is 20 Foot, containing 83 Pound.

To Sum up,

		l.		*l.*
Steerage and Forecaſtle			for Knees,	609
Rings	For Knees	33	Ports	138
	Ports	$10\frac{1}{2}$	Hinges and Hooks	86
	Poop-Knees	4	Poop Knees	138
	Strings in the Waſte	8	Strings in the Waſte	80
	Ditto Cabbin	$8\frac{3}{4}$	Ditto Great Cabbin	94
	Cat-heads	4	Cat-heads	83
	Total	$68\frac{1}{4}$	Total	1228

Forlocks	For Port-bolts	$5\frac{1}{4}$
	Cat-heads	2
		$7\frac{1}{4}$

To make a Total Sum hither,

	Tun.	*C.*	*q.*	*l.*
Content of all the Iron as high as the lower Gun-deck, *&c.*	17	11	2	17
For the Middle-deck	3	17	2	20
For the Upper-deck	2	12	2	14
For the Quarter-deck, Forecaſtle and Poop	0	10	3	16
Total	24	12	3	11

I come next to the Bolts for the Rigging, *&c.*

Span-ſhackle for the Davit, Bolts of 2 Inches Diameter 12 Foot $\frac{1}{2}$ long, containing 131 Pound $\frac{1}{3}$.

Top-tackle Bolts 4, of 2 Inches Diameter, and 9 Foot long, they are 36 Foot, or 378 Pound.

Eye-bolts for the Main and Fore-ſheets, 4 of 1 $\frac{1}{2}$ Bolt, 7 Foot $\frac{1}{2}$ in all, or 45 Pound.

Eye-bolts for the Top-ſail Hallyards, 4 of 1 $\frac{1}{4}$ Bolt, 7 Foot long, or 29 Pound.

Bolts for Clew-garnets, 4 Eye-bolts 6 Foot long.

Bolts for Hooking Tackles 6, 14 Foot long.

Bolts for Horſes in the Head and Mizon-ſheet 4, 8 Foot long, in all 24 Foot, or 81 Pound.

A Calculation for the Chain-Plates.

The Plate to be equal to two 2 Inch Bolts, the Breadth of the Channel, which in this is 2 Foot 7 Inches.

The Dead-Eye to be half of the Diameter of the Maſt, which in this is 39 Inches, the Half is 19 $\frac{1}{2}$, Circumference is 61, allow 15 Inches more for Hooking, which will be 76 Inches, or 6 Foot 4 Inches.

Tun. C. q. l.

There will be 18 Chain-plates, whoſe Weight will be —— 0 19 2 0

Then to proportion the Fore Chain-plates from the Main, ſay, As the Square of the Diameter of the Maſts in the Partners is one to another, ſo ſhall the Square of the Diameter of the Bolts be one to another; ſo that the Diameter of the Bolt in theſe 4 Chain-plates will be 1 Inch and $\frac{11}{16}$ doubled as aforeſaid, according to the Breadth of the Channel, ſo that in this Fore Channel the Length will be 5 Ft. 5, ſingle of 1 Inch $\frac{11}{16}$, and each Binding will be 5 Ft. 5 Inches of 1 $\frac{11}{16}$ Bolt.

Then 176 Feet × by 7 4 8 $\frac{1}{4}$, the Weight of 1 Foot of Bolt of that Size, is 11 *c.* 3 *q.* 6 *l.* the Weight of the Fore Chain-plates.

The Bolt for the Mizon Chain-plates will be 1 Inch and $\frac{4}{16}$, ſo that the Mizon Chain-plates being 10, at 4 Foot 7 Inches and $\frac{1}{2}$ the ſingle Length, which is 3 Foot 3 Inches each, by 1 Inch $\frac{4}{16}$ Bolt, is 96 Pound $\frac{1}{2}$ for Plates, Diameter of the Dead-eye is 11 Inches, Circumference is 33 $\frac{1}{2}$ allowing 10 In. for Hooking, it makes 43 $\frac{1}{2}$ or 3 Foot 7 Inches $\frac{1}{2}$, then the Weight of the Bindings will be 107, and ſix Pounds put to 96 $\frac{1}{2}$ it is in all 204 Pound.

Total Content of Iron for the Mizon Chain-plates is 1 *c.* 3 *q.* 2 *l.* and ſuch a Reducement will do for the Mizon Chain-plates, according as the Square of the Diameter of the Maſts are one to another; but not for Main and Fore Chain-plates on Board of ſmall Shipping, the Strain being altogether different, as I ſhall particularly conſider hereafter.

I ſhall allow 4 Back Stay-plates with Stools equal to the Mizon Channel-plates, which will be 82 Pound, and eight Back Stay-plates in the Channels by the ſame ſized Bolt of twice the Breadth of the Channel, 2 Ft. 8 In. being the Medium Breadth, which being doubled, is 5. 4 × by 8 is 42 Foot 8 Inches × by 2, 15 $\frac{4}{5}$ the Weight of one Foot of the ſized Bolt the Weight is 125 Pound $\frac{1}{4}$.

Then for 8 Dead-eyes of 11 Inches Diameter, is 3 Foot 7 Inches and a half each for Bindings, which is 86 Pound Weight.

Ring-plates 8, of the Size of the Back Stay-plates, and equal in Weight, is 125 pound $\frac{1}{4}$, with 8 Rings 19 Inches Circumference by 8, is 12 Foot 9 Inches, which is 83 pound.

For calculating the Weight of the Chain-bolts, obſerve, that the Head of the Bolt muſt be 4 Diameters of the Bolt for Bigneſs, and 1 Diameter for Length.

Then the Main Chain-bolts will be 18, of 2 Foot long each of Bolt of 2 Inches $\frac{1}{4}$ Diameter, ſo that the Head will be 9 Inches for the Allowance, which in all is 49 . 5 × by 13 . 5, the Weight of 1 Foot of that ſized Bolt, makes 668 pound $\frac{1}{2}$.

Then for the Foremaſt Chain-plates, ſay, As the Square of the Diameter of the Bolt applied to compoſe the Chain-plates, are one to another, ſo is the Square of the Diameter of the Bolt applied to compoſe the Chain-bolts one to another. and then the Size of the Bolt to make the Fore Chain-bolt will be 1 Inch and $\frac{7}{8}$ Diameter. There will be 16 of them, 2 Ft. long each, and 4 Diameter for each Head, make in all 42 Ft. 8 In. the Content will then be 394*l.* $\frac{3}{4}$.

Mizon Chain-bolts 10 of 12 in. long, is 10 Ft. Diameter 1 Inche $\frac{3}{8}$, Head 4 Inches $\frac{3}{4}$, in all is 14 Foot, or 52 pound.

Back Stay-plates 4 for the Stool-plates at 5 *l.* each Bolt is 20 pound.

Bolts for the Back Stay-plates and Ring-plates in the Channels at 2 Foot each by the Size of 1 Inch $\frac{3}{16}$ Bolt, Content is 119 pound $\frac{1}{2}$.

Rings for Chain-bolts 46 pound $\frac{1}{2}$, Main Forlocks 23 $\frac{1}{4}$.

To Sum up

	Tun.	*C.*	*q.*	*l.*
For Main, Fore and Mizon Chain-plates	1	13	0	12
For 4 Back Stay-plates, and 8 others, and 8 Ring-plates	0	4	0	09
For Main, Fore and Mizon Chain-bolts	0	9	3	16
For the Back Stay-bolts	0	1	1	19
Total	2	8	2	00

	l.
Rings for Fore Chain-bolts	24
Forlock	12

For Channel-bolts. Main Channel-bolts 18, which ſhall be general for all Channels to have a Number of Bolts equal to the Number of Chain plates, and they to be plac'd as near as poſſible to the Score that is cut for the Plate, but not in it.

Eighteen Bolts of 4 Ft. each of 1 $\frac{1}{8}$ Bolt, is 223 pound.

For the Fore Channels 16 Bolts of 4 Ft. 1 Inch long — by 1 Inch $\frac{1}{16}$ Bolt, is 194 pound.

Mizon Channel 10 Bolts 2 Ft. $\frac{1}{2}$ each of $\frac{7}{8}$ Bolt, is 50 pound $\frac{3}{4}$.

	C.	*q.*	*l.*
The Total Sum for Channel-bolts is	4	0	12 $\frac{3}{4}$.
Rings for Mizon and Back Stay-bolts	0	0	11
Forlocks	0	0	05

A Calculation for the Rudder-Irons.

Memorandum, That a Ship of 1400 Tuns Rudder-Irons weighed 22*c.* 0*q.* 14*l.* and a Ship of near 500 Tuns weighed,

	C.	*q.*	*l.*
The four Braces weighed	3	3	25
One Gudgeon	0	1	9
Five Pintels	2	3	7
Total	7	0	13

The Weight of Iron belonging to any Rudder, to the Weight of Wood will be ſuitable as 7 to 27, or as 1 to 4. For the Weight of the 500 Tuns Ship's Rudder is near 2700, and the Weight of the Ship's Rudder which I am calculating, will be 9800, and then the Iron will be 2400 *c.* 56 *l.* and when you have the whole Weight you may proceed to Particulars, ſaying, As the whole Weight of the Iron in one Rudder is to the whole Weight of the Iron in another Rudder, ſo are the Braces; or the Pintels in one Rudder to the Braces and Pintels in the other Rudder.

In this great Ship there will be 8 pair of Irons, that is, Pintels 8, Braces 7, and Gudgeon 1.

	C.	q.	l.
So that the Weight of each Brace will be ——— ———	1	3	0
And the Weight of each Pintel will be ——— ———	1	1	20
And the Weight of the Gudgeon will be ——— ———	1	0	0

Or otherwiſe let each of the Braces be equal to as much 2 Inch and ½ Bolt as will girt the Rudder at the lower End, which will be 14 Ft. 4 Inches.

And each of the Pintels to be equal to as much 2 Inch Bolt as will girt the Rudder at the upper End. The Gudgeon may be ſo too, though they do not come exactly even. And I ſhall refer the Smith to the Shape, ſince it's his daily Practice.

Content of the Rudder-Irons is thus,

	Tun.	C.	q.	l.
For eight Braces ——— ——— ———	0	14	0	0
For ſeven Pintels ——— ——— ———	0	10	0	0
For one Gudgeon, or upper Brace——— ———	0	1	0	0
Total	1	5	0	0

Two Hoops for the Rudder-head, equal to 4 Inch Bolts round the Head, which will be 32 Ft. or 85 pound.

Four Plates equal to 4 Inch and ½ Bolts of 3 Ft. ½ long, is 14 Ft. or 84 pound.

Eight Bolts through the Head by 1 ⅓ Bolt 16 Ft. 54 or pound.

Two Ring Bolts for the Back, by 1 ¼ Bolt. Ring 25 ½ Circumference, the Bolt 23 ½, in all 8 Ft. or 33 pound.

The Bolts for faſtening the Wood together 2, to every Brace equal to the Length of the lower Part of the Rudder by 1 ¼ Bolt, is 96 Ft. or 298 pound.

To Sum up

	Tun.	C.	q.	l.
Bolts to faſten the Wood ——— ——— ———	0	3	2	0
Two Ring-bolts ——— ——— ———	0	0	1	5
Bolts in the Head ——— ——— ——— ———	0	0	1	26
Four Plates ——— ———	0	0	3	0
For Hoops ——— ——— ——— ———	0	0	3	1
For the Cleat and Bolts ——— ———	0	0	1	4
For the Gooſe-neck ——— ——— ———	0	1	0	0
	0	7	0	8
Rudder ———	1	5	0	0
Total for the Rudder and Tiller ———	1	12	0	8

Some Obſervations to ſize the Gooſe-neck and Cleat for the Tiller.

The Rudder at the Head being 2 Ft. 1 Inch, and 1 Ft. 8 Inches, the Square is 1 Ft. 10 Inches ¾, the Square of 11 and 12 is near 11 ½, the Area of 1 Ft. 10 Inches ¾ is 520. Area of 11 ½ is 132 ¼ near as four to one. Then the Area of the Ship's Rudder at the Head being 576, the Area of the Tiller is 144, and the Side of conſequence 12 Inches, the middle Part of the Tiller will be 9 Inches, and the Gooſe-neck, though ſo very various, I ſhall allow to be 2 Ft. long.

I do believe the Strain of any Tiller to be near the Middle, provided his greateſt Subſtance is continued through the Rudder Head, the Gooſe-neck I ſhall allow to be equally ſtrong with the Tiller, or rather ſtronger.

Then if the Gooſe-neck was to be as long as the Tiller, it ought to be 3 Inches and $\frac{1}{20}$ Square, to make it equally ſtrong; but ſince the Tiller from the Rudder to the Whip-ſtaff is near 32 Ft. long, the Length will be as 16 to 1, and ſo ſhould the Area be if the Strain was equal, which would then be but $\frac{58}{100}$ Parts of an Inch for the Gooſe-neck, but ſince the Neck is affected by the Whipſtaff's working, and alſo the Tiller is better ſupported in the Middle, when the Uſe is Violent; the Neck ought to be made in Proportion to the Length between the Middle of the Tiller and the End, which is 8 times $\frac{58}{100}$, or 2 Inches $\frac{15}{100}$, for the Square of the Neck.

The fore and aft Part to be half the up and down, which is 1 Ft. for the Staff to work on, which makes 3 Ft. for the Length of the Iron of 2 Inches $\frac{15}{100}$ Parts Square, which will be 2 Inches $\frac{3}{4}$ in a round Bolt, and that will be 60 pound. Now in Conſideration of fortifying the End of the Tiller, which is found in great Danger by the Twiſt in Steering, I ſhall allow as much more for the Band and four Straps, which will then be 120 pound for the whole Gooſe-neck.

Then for the Cleat of the Rudder to work on a Sweap, to be ſtrong enough to bear half his Weight, which is 4 c. $\frac{1}{2}$, and ſince every Matter, though ever ſo different in the Species, may be in all Likelihood able to encounter one another, being of equal Weight, I ſhould have conſider'd theſe Parts accordingly, were they ſet oppoſite, and did ſtrain one againſt another, but the Caſe is otherwiſe, the Iron is only a Conveniency to hang up the Wood, and to keep it Horizontal, and in its natural Poſition, and therefore I believe that a Cleat of Iron of 1 Ft. Length, equal to 1 Ft. of the Tiller, where it's put, may be ſufficient for that purpoſe, the Wood being 8 Inches of 1 Ft. which is 768 Inches.

The Squre of 8 is 64 for the Area of the Wood, then as 35 is to 4, ſo is the Square of the Wood to the Square of the Iron, which is 9 Inches $\frac{7}{20}$, the Side of which is 2 Inche $\frac{7}{10}$ in a Square Bar, but in a Round it is 3 Inches $\frac{11}{20}$; then the Cleat will be 32 pound, with 2 Bolts of an Inch, 9 Inches each, which is 4 pound.

A Calculation for the Head.

Bolts for the Knee 52 Ft by 2 Inches $\frac{1}{8}$ Bolt, though they ought to be diminiſhing in Bigneſs, according to the Variety of Length, from the Area of the Throat Bolt, which I allow in this Ship 2 Inches $\frac{1}{4}$, but this Calculation I ſhall make from 52 Ft. of an Inch and $\frac{1}{8}$ Diameter Bolt, which is 617 pound to faſten the Knee.

Then for the Gripe 20 Ft. by 1 $\frac{7}{8}$ Bolt is 185 pound.

For 4 Cheeks by 1 $\frac{7}{16}$ Bolts, 16 Bolts through the Side 2 Ft. 9 Inches each, 44 Ft. and 10 Bolts through the Knee of 2 Ft. 6 Inches long, 25 Ft. or 380 pound.

For the Lyning of the Bows 1 $\frac{7}{16}$ Diameter Bolt, and for every Ft. the Lynings are, (excepting one) each way × 4 : 6. ſhall give the Number of Bolts, as in this, let the Lynings be 5 Ft. 6 In. Depth, and twice that Depth long, × 10 by 4 . 6, there is 45 Bolts of one Side, which is 90 in all of 2 Ft. 3 Inches long, it's 202 Ft. $\frac{1}{2}$ or 1113 pound.

For faſtening the Lyon Trail, and Lace, Kelſon and Stander 10 Diameters of the Body of the Lyon, which in this will be 3 Ft. $\frac{1}{2}$ × by 10. is 35 Ft. of 1 $\frac{7}{16}$ Diameter Bolt, is 193 pound.

For the Timbers and Rails, Knees and Croſs-beams and Brackets, 84 Ft. of an Inch Bolt, or 223 pound, 3 Horſe bolts Eyes of 13 Inches Circumference Length, in all 7 Ft. by 1 $\frac{1}{2}$ Bolt, is 42 pound.

	Tun.	*C.*	*q.*	*l.*
Total Content for the Head-bolts is ——— ———	1	4	2	10

Rings

		l.		l.
Rings	For the Knees	14$\frac{1}{2}$		
	For Gripe	6	Forlocks	7$\frac{1}{4}$
	For the Lyon Trail and Stander	4		3
	For Timbers	16		
		40$\frac{1}{2}$		10$\frac{1}{4}$

For the Stern.

For Helm-port, Tranſum, and Middle-Deck 1 $\frac{1}{4}$ Bolt 12 of 2 Ft. long, and for 4 Knees, 16 Bolts of 2 Ft. and a half, and 12 of 3 Ft. in all is 76 Ft. or 456 pound.

For the Upper-Deck Tranſum, and the Middle-Deck Lights, 12 Bolts of 1 Ft. 6 Inches long, and 24 Bolts of 2 Ft. long, is 48 Ft. and 18 is 66 Ft. of 1 $\frac{1}{8}$ Bolt, is 213 pound.

For the Quarter-Deck Tranſum, and Upper-Deck Light Tranſum, 12 Bolts of 15 Inches long, and 24 of 18 Inches long, which being 51 Ft. by an Inch Augre, is 135 pound.

For the Poop Tranſum, and Quarter-Deck Lights Tranſum 34 Ft. of Bolt by $\frac{7}{8}$ of an Inch Augre, and for the Gunnel at the Tafferal 6 Ft. which together is 40 Ft. or 31 pound.

	C.	q.	l.
Total for the Stern is	7	3	16
Rings for the Stern	0	1	14

For the Galleries.

Bolts for the Lower Stools 12 by 1 $\frac{1}{4}$ Bolt Augre 3 Ft. long each, which is 36 Ft. or 149 pound.

For the ſecond Stool 12 Bolts by 1 $\frac{1}{8}$ Augre, 4 Ft. long each, which is 48 Ft. or 162 pound.

For the third Stool 12 Bolts by 1 $\frac{1}{16}$ Augre, 3 Ft. $\frac{1}{2}$ each, which is 42 Ft. or 124 pound.

For the fourth Stool 8 Bolts by $\frac{7}{8}$ Augre, 3 Ft. long each, which is 24 Ft. or 49 pound and a half.

	C.	q.	l.
Total for the Galleries is	4	1	5
Rings for the Galleries	0	0	14$\frac{1}{4}$

Bolts for 4 Scarphs in the Keel, 8 in each of 20 Inches long, is 53 Ft. by 1 $\frac{1}{4}$ Bolt, 216 pound $\frac{1}{2}$.

For two Scarphs of the Stem, 8 Bolts in each, by 1 $\frac{1}{4}$ Bolt, 18 Inches each is 24 Ft. or 99 pound.

Five Bolts through the Main Tranſums and Poſt, will be 20 Ft. in all by 1 $\frac{1}{4}$ Bolt, is 83 pound.

	l.
Ring for the Keel	13$\frac{1}{2}$
for the Stern	6$\frac{3}{4}$
for the Tranſums	2

I ſhall proceed to the Lanthorn-Crank, wherein I ſhall endeavour to give ſuch a ſuitable Demonſtration that may not only help ſizing ſuch a Critical Utenſil, but alſo help to demonſtrate ſeveral others of ſuch a Nature.

Firſt then, according to the Size of ſuch a large Ship's biggeſt Lantern; I allow it to be equal to a Cylinder, whoſe Diameter ſhall be 5 Ft. and Circumference 15 Ft. 8 Inches, and the Length 7 Ft. $\frac{1}{2}$, then the Superficies will be 117 Ft. I ſhall likewiſe allow that this 117 Ft. on the Superficies, (conſidering the Workmanſhip and Bands of the Lantern) ſhall be equal to a Tin Plate of $\frac{1}{8}$ of an Inch thick; then 96 Ft. will be equal to one ſolid Foot of Tin, ſo that the 117 ſhall be equal to one Ft. and $\frac{5}{24}$ of a Foot, or more nice ^{21} of a Foot.

Tin to Iron is as 1554 is to 1680 in Weight, and 15 Inches of ſolid Iron is 4 Pound, then the Inches contained in the Tin is 526 Pound.

But being almoſt poſitive that ſuch a Ship's biggeſt Lantern don't weigh half five Hundred Weight, I ſhall allow the Tin to be $\frac{1}{16}$ Part of an Inch thick, and then the Weight of the Lantern will be 263 pound Weight; and if the Lantern Cranks are made Artificially, as ſome Parts are ſet Angles between the Horizontal and a Perpendicular Poſition, half of that Weight in Iron may ſupport and ſave from Accidents, a Lantern of four times the Weight of the Crank, which here I allow to be 130 Pound, and that is equal to 22 Ft. of Bolt, 1 Inch and a half in Diameter, which may make ſuch a Crank ſuitable to ſet the Lantern Commodious and Beautiful Rakeing aftwards.

The two Side Lanterns I allow to be $\frac{5}{8}$ of the Diameter of the Middle, and the Weight of Iron work to be agreeable to $\frac{8}{10}$ of the Weight of the Middle, which will be each 103 Pound, which together is 206 Pound.

Area's of the Lanterns are 14 . 0, and 17 . 7, which as they are one to another, ſo ſhall the Weight of the Iron-work be one to another.

The Braces I ſet oppoſite to the Impulſe of Wind, which together in this great Lantern ought to be equal to a Bolt of $\frac{87}{100}$ Parts of an Inch, but this Utenſil is generally ſold by the Foot.

The Side-Cranks will be equal each to 18 Ft. and half of an Inch, and $\frac{7}{10}$ Diameter Bolt, which Allowance will make the Lanterns agreeable in their Standing, according to their reſpective Diameter and Heights.

And in this Conſideration it's not only requiſite to mind the Weight of the Lantern and Wood-Stools for them to ſet on; but alſo the Impulſe of Wind againſt ſuch large bulky Bodies.

Iron to Wood being as	35 to 4
Oak to Water as	8 to 9
Water to Air as	800 to 1

Thus allowing the middle Lantern to be 10 Ft. long and 5 Ft. Diameter, and that the Body ſhall be half, or 5 Ft. of the Length, and the Bottom and Top 2 Ft. and a half each; however I allow the Impulſe of Air to be properly againſt a Cylinder Body of 7 Ft. and a half Long, and 5 Ft. Diameter, and the Superficies 37 Ft. and a half.

Five Ft. is 60 Inches, and 7 and a half is 90 Inches, then × 60 by 90, it's 5400 Inches the Superficies of the Lantern in Inches, and what the Impulſe of Wind bears upon.

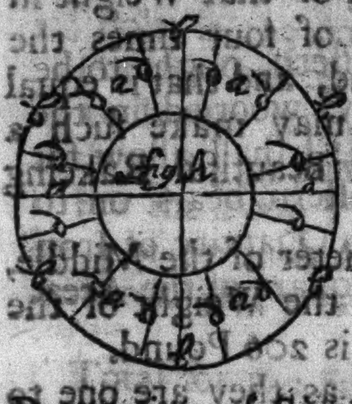
Air to Water being as 1 to 800, then the 5400 Inches of Air is but equal to 6 Inches $\frac{3}{4}$ of Water; Water to Oak being as 9 to 8, ſo that 6 Inches $\frac{3}{4}$ of Water is equal to 7 Inches $\frac{6}{10}$ of Wood; Oak to Iron being as 4 to 35, ſo that 7 $\frac{6}{10}$ of Oak is equal to $\frac{87}{100}$ of an Inch of Iron.

	C.	q.	l.
The Weight of three Cranks will be	3	0	0
Rings and Forlocks	0	0	2 $\frac{1}{4}$

Some Obſervations for Calculating the Iron-work of Capſterns.

The Material Iron-work allowed to Capſterns are the Palls, which may alſo be term'd Stops or Trigs, which Parts formerly were long unſhapely Things, and the greateſt Strain lay in a ſmall Bolt that was drove through a Hole made in the Pall; but now they are made more nice, and fitted to one of the Whelps very Convenient, and more Material; but of the Proportion according to the Bigneſs of the Capſtern, I ſhall more particularly conſider.

Wood to Iron is as 4 to 35, and ſo I preſume the Pall ſhould be to make it ſuitable to the Capſtern.



Theſe Palls are called Engine-Palls, and being faſtened to the Capſtern, Work round with it, by which means they are drawn in a Circle, deſcribed by the outer Part of the Whelps, as in the Figure *A*, the Whelps being half the Diameter of the Barrel, or 17 Inches, ſo that the greateſt Circle is 68 Inches, or 5 Ft. 8 Inches Diameter. You are to take Notice, that the ſix *a*'s are ſix Whelps, *b*'s are the outer Boundings of the Whelps, and *c*'s the Diameter of the Barrel; *d*'s ſhews the Sides of the Whelps; then the Pall at his greateſt Length need be, nay, can be no longer than from *d* to *d*, which is 15 Inches. The Proportion of Strength ſide-ways ſhall be as the Length of the Capſtern is to the Length of the Pall, ſo the Area of the Capſtern's to the Area of the Pall.

The Length of the Capſtern from the Head to the Toe, may be 12 Ft. and the Area is 720 Inches; the Length of the Pall is 15 Inches, then as 12 Ft. is to 15 Inches, ſo is 720 Inches to 74 Inches, the Side of which is 8 Inches $\frac{6}{10}$, which is to be the Square of the Pall; provided the Strain of the Capſtern was agreeable to the Strain of the Pall: But it is really different; ſince all the Men heaving at the Capſtern-Bars affect the Capſtern; but the Pall is only a Stop to Reſt, and little affected with the Motion of the Ship; for there is at leaſt 100 Men in the greateſt Extremity ſtraining upon the Capſtern, and not one upon the Pall, which hundred Men, were they only to haul without the Help of Engines, they would lift or draw a Weight equal to their own, which is 7 Tuns; but every one of theſe hundred Men's Strength will be encreaſed as 6 to 1, which will then be 42 Tuns, and that is the Weight which may be expected to be lifted by an Hundred Men without the Help of any other Artifice beſides the Aſſiſtance of the bare Capſtern.

However, the Weight to be removed is 2008 Tuns, notwithſtanding the greateſt Reſt has not Power to reſiſt the ſmalleſt Motion, for a Man with his Hand will be able to move the biggeſt Ship, provided there be no other Reſiſtance than a ſtill and ſurrounding Water.

Then allowing that this Hundred Men may move the Capſtern without ſtraining of it; that is, they may move it with a Purchaſe very near the Center or cloſe to the Capſtern; but when they are ſubdivided, and exert their Strength towards the Bars-end, the Strain will be as 6 to 1, and ſo the Difference between the Capſtern and the Pall ought to be, and then the Area will be 12.3, the Side of which is 3 and a half by 15 Inches, which is 49 Pound $\frac{2}{10}$.

A Fourth Rate, or Ship near 650 Tuns, Jeer Capſtern of 10 Ft. Length, and 19 Inches Diameter, the Area is 286.7, the Length of the Pall, 8 Inches, then as 10 Ft. is to 8 Inches, ſo is 286.7 to 19 Inches, the Side of which Area is 4 Inches $\frac{7}{20}$.

Now as the Areas of the Capſterns are one to another, ſo ought the Number of Men applied to heave at them be, which will be 40 Men, or near three Tunns; the Bars or Leaver in this Capſtern will be but 9 Ft. as the others are 12. Nay, if you will apply the Number of Men in this, as in that, the Bars ſhould be but 4 Ft. 9 Inches, proportionable to the Strength of the Capſtern. However, I allow them 9 Ft, and then the Proportion will be as 4 . 5 is to 1; ſo that the Pall or Area of 19 divided into 4 . 4 Parts, is 4 . 2 or the Area, the Side of which is 2 Inches $\frac{5}{100}$, and this ſmall Capſtern, according to the Strength of the Spindle, can heave but 16 Tuns $\frac{5}{10}$, no better than the large Capſtern can heave 42 Tuns.

Content of the ſmall Pall is 8 pound $\frac{5}{10}$, beſides the Hinge.

The large Ship's main Capſtern has alſo two Palls, tho' different in the Shape, and the two will be 98 Pounds $\frac{2}{10}$. The Hinges to hang them may be $\frac{1}{4}$ of that Weight, which will be 24 and a half. So that the whole Weight for the Palls and Hinges is 122 Pounds and a half.

The lower End, or what is term'd the Toe of the Capſtern, ought to be well ſecured with Iron Bindings, ſince that Part is always wooried in the Uſe; and being reduc'd to half the bigneſs of the Spindle, I ſhall allow for a Hoop round the Toe, and for a Sawcer that the Capſtern bears on to work in, an equal Weight, and that Weight to be equal to a Quantity of Iron near to the Weight of the Wood or Toe's Area × by the Square of the Area.

Example.

Diameter of the Toe is 15 Inches, Circumference is 47 . 5, Area is 174 . 3, × by the Square Root 13 . 2, is 2300 . 7 Inches of Wood.

Wood to Iron is as 4 to 35: So that the Iron allowed for the ſame will be 262 Inches $\frac{9}{10}$.

Then the Hoops will be equal to 7 Bolts of 1 Inch Diameter, and the Length to be 7 Circumferences of the Toe, the Sawcer equal to the Diameter of the Toe, and 1 Inch and a half thick.

Then the Weight of each Hoop, one round the Toe of the Capſtern, and the other in the Socket of the Step, will be 74 Pounds $\frac{15}{200}$, or $\frac{1}{2}$ a Pound.

And the Sawcer will be 69 Pounds $\frac{6}{17}$, or $\frac{1}{2}$ a Pound.

The Weight of the Iron Work of all Capſterns may be allowed in Proportion to the Area of the Spindle.

A Capſtern of 34 Inches Diameter of the Barrel, 18 Inches will be the Diameter of the Spindle.

Area of the Spindle 720 Inches.

Then the Jeer Capſtern's Spindle, ſuitable to ſuch a main Capſtern, will be 28 Inches and a half Diameter, the Circumference is 89, Area of the Spindle is 634 . 1.

Treble Capſtern's Diameter of the Barrel —— 18 Inches
Diameter of the Spindle —— —— 17 $\frac{1}{2}$
Circumference —— —— 52

One Hoop for the Partners of the large Ship's main Capſtern half an Inch thick 3 Inches broad, is 112 Inches long, or 9 Ft. 4 Inches, at 5 Pound 1 Ounce to every Foot, is 47 Pounds.

Ribs for the Capſtern equal to half the Number of Inches contain'd in the Circumference of the Capſtern of an half Inch Bolt, which may be general for ſuch a part, 54 Ft. of half Inch Bolt is 36 Pound.

Bolts for the Whelps, 2 to each, by 1 $\frac{1}{2}$ Bolt of the Diameter of the Barrel for length, which is 2 . 10, 12 of them being 34 Feet, or 140 Pounds $\frac{3}{4}$.

Bolts for the Choks, 12 of $\frac{3}{4}$ Diameter of the Capſtern for the Length of 1, which is 2 Ft. 1 Inch, or 25 Ft. by a one Inch Bolt; it's 66 Pound.

Bolts for the Thrumhead, 12 of 1¼ Diameter 1 Ft. 3 Inches each, its 15 Ft. or 61 Pounds ¾.

One Bolt for the Toe of $\frac{1}{10}$ of the Diameter of the Toe, which is 15 Inches by a Bolt of One Inch and a half Diameter, the Head of the Bolt to be equal to 4 Diameters, and in Length 1 Diameter, which in all is 6 Inches, and the Length of the Bolt the Diameter of the Toe, which is in all 21 Inches, or 10 Pounds and a half.

To Sum up,

	For the Main Capſtern. l.	For the Jeer Capſtern. l.
Iron Hoops for the Partners	47	41½
Ribs	36½	31¾
Whelp Bolts	143¾	127
For Chocks	66	58
For the Head	61¾	54½
For the Toe	10½	9¼
Palls	122¼	109
Hoops and Sawcer	144	127¼
To faſten the Head	27	23¾
Rings and Forlocks	6½	5¾
	681	587¾

	c.	q.	l.		c.	q.	l.
Or	5	3	2.	Or	5	0	27¾

For the Treble Capſtern.

	l.
Iron Hoops for Partners	14½
Ribs	11
Whelp Bolts	44
For Chocks	20
For the Head	19
For the Toe	3¼
For Palls	37
Hoops and Sawcer	44¼
To faſten the Head	8¼
Rings and Forlocks	2
	233¼

	C.	q.	l.
Or	1	3	7¼

Before I proceed any farther on this Subject, I ſhall make a Total Sum of this large Ship's Iron Work.

	t.	c.	q.	l.
Which will be found	32	12	0	26¼

There are yet more Iron Works belonging to the Ship, but they may be term'd Paſſengers, they chiefly belonging to the Equipping: The Nature of which I ſhall not at preſent look into, only ſhall make an Obſervation of the Pump Chain, which I take to be a material Part in the Carpenter's Care.

I never could obſerve any Difference in the Bigneſs of the Bolt, that the Pump's Chain is made with, altho' the Difference in Ships Depths in Hold is ſo very much, and from thence the different Strain muſt of Conſequence be not only from the Degrees of Length in ſuch Materials between a great Ship and a ſmall one, but alſo from the various Depths that the Water is drawn from, and therefore it would be very happy towards the Preſervation of ſuch huge large Ships, if there could be an Additional Force applied to work their Chain-pumps more than what is uſual to be, and then the Chain's Bigneſs might be made ſuitable to the Length, and agreeable to the Draught of Water extra more in a large Ship than is contain'd in the Hold of a ſmall Ship; but at preſent I ſhall only conſider the Weight of the Chain, according to the Cuſtomary Bigneſs.

The largeſt Bolt that is put to compoſe ſuch Chains, has ben obſerved to be 7/8 of an Inch Diameter, and the ſmalleſt Sort 3/4 of an Inch: And they being in two entire Parts, each of thoſe Parts may be alſo counted two. So that at leaſt the Pump-Chain may be counted 5 Depths in Hold, meaſured from the lower Part of the Floor-Timbers, to the Upper-Deck, which in ſuch a large Ship is at leaſt 27 Ft. and a half, and that × by 5, is 137 Ft. and a half, which of a 7/8 Bolt is 279 pound. Any 4 ſuch Chains is 1116 pound.

A Ship's Depth, (that way meaſured) of near 400 Tuns, is 20 Ft. × by 5, is 100 Ft. of a 3/4 Bolt, is 150 pound, the two will be 300 pound; ſo that the Weight of the ſmall Chains to the great ones, are as 7 to 13, near as 1 to 2, and the Depth as 11 to 16, and therefore the Purchaſe, or Artifice requiſite to draw Water out of one Ship, to what it is to draw Water out of the other, is as 3 to 8; and the great Ship ought to have 8 Mens Strength applied to draw an equal Quantity of Water out of her Bottom, to 3 in ſuch a ſmall Ship: Beſides the Quantity of Water that will be more in the great Ship than in the little Ship before it appears, and requires to be pump'd out.

Now ſince it's very plain that the Purchaſe and Strength applied (according to Cuſtom) in ſuch Ships are near equal, it would be very requiſite to make the Application ſuitable, and conſider ſuch a beneficial Faculty, and make the Conveniency agreeable to the Uſe.

In the next Place I ſhall conſider ſomething of the Nature of the Rings and Forlocks which belay the Bolts, which although a ſmall piddling Material, it will not be at all improper to bring them to a general Proportion from the Bigneſs of the Bolt they are applied to.

In doing of which I ſhall firſt begin and allow that the Ring ſhall be equal to an Inch in Length of the reſpective Bolt it faſtens, and the Forlock half ſuch a Weight.

Inches. Diameter of the Bolt in Inches and Parts.	*Ounces.* The Weight of an Inch of Bolt of the reſpective Size; but believing that ſuch a Proportion will not be ſufficient for the large Bolts, I ſhall calculate it from the Length of the Diameter of the Bolt in all Bolts that's above an Inch in Diameter.	*Ounces.* The Weight of the Ring of each reſpective ſized Bolt in Ounces and Parts of Ounces, half this ſhall be the Weight of the Forlock.	*Ounces.* The Weight of the Forlock in Inches and Parts.
0 1/2	0 2/10	0 2/10	0 2/20
0 5/8	1 38/100	1 38/100	0 69/100
0 3/4	2 0	2 0	1 0
0 7/8	2 13/20	2 13/20	1 13/40
1 0	3 1/5	3 1/5	1 7/10
1 1/16	4 0	4 1/4	1 1/8
1 1/8	4 1/2	5 0	2 1/2
1 3/16	4 15/16	5 8/10	2 9/10
1 1/4	5 1/2	6 8/10	3 4/10
1 5/16	6 1/10	7 9/10	3 19/20
1 3/8	6 3/4	9 2/10	4 6/10
1 7/16	7 7/20	10 1/2	5 1/4
1 1/2	8 0	12 0	6 0
1 9/16	8 6/10	13 4/10	6 8/10
1 5/8	9 1/4	14 9/10	7 9/20
1 11/16	10 0	17 0	8 5/10
1 3/4	10 8/10	18 8/10	9 4/10
1 13/16	11 6/10	21 0	10 5/10
1 7/8	12 3/10	23 0	11 5/10
1 15/16	13 2/10	25 1/2	12 3/4
2 0	14 0	28 0	14 0
2 1/8	15 8/10	33 1/2	16 1/4
2 1/4	17 4/10	39 0	19 1/2

Memorandum on the Weight of Rings according to the Cuſtom. A Ring of 3 Inches Diameter, the Hole was 1 and a half, the Thickneſs half an Inch, and weighed 5 Ounces $\frac{3}{4}$.

Another Ring of 2 Inches Diameter, the Hole was $\frac{15}{16}$, the Thickneſs $\frac{3}{8}$ of an Inch, and weighed near 3 Ounces.

Another Ring is 1 Inch $\frac{3}{8}$ Diameter, the Hole $\frac{9}{16}$, and Thickneſs $\frac{1}{4}$, weighing near an Ounce and a half.

Another Ring of 3 Inches $\frac{3}{4}$ Diameter, the Hole 2 Inches, Thickneſs half an Inch, and Breadth of the Ring $\frac{7}{8}$ of an Inch weigh'd 1 pound, obſerving that the Rim is ſomething leſs than half the Thickneſs.

I proceed now to the Calculation of the Iron-work of a Ship of 250 Tuns.

Three Floor Riders 12 Bolts in each of 1 Ft. 10 Inches long in the Medium, by $\frac{7}{8}$ Diameter Bolt 66 Ft. Crutches 2, Bolts 24 of 2 Ft. 3 Inches long by $\frac{7}{8}$ Bolt 54 Ft.

Mizon Step 27 Ft. of Bolt of $\frac{7}{8}$ of an Inch Diameter, Fore-Step 16 Bolts, 2 Ft. each, it's 32 Ft. by $\frac{7}{8}$ of an Inch Diameter.

Breaſt-hooks 4, 10 Bolts in each of 18 Inches long, 40 Bolts or 60 Ft.

Tranſum Knees 6, Bolts in each 14 by $\frac{7}{8}$ of an Inch Bolt, they are 15 Inches long, containing 105 Ft. ſo that all this Article contains *6 c. 0 q. 26 l.*

Orlop-Beams kneed with 6 Knees by a Bolt of $\frac{7}{8}$ of an Inch Diameter, 6 Bolts to each Knee, 18 of 14 Inches long, and 18 of 1 Ft. long and 5 Inches, which contains 43 Ft. and a half or 88 pound

Gun-Deck Knees, 38 lodging Knees and 38 hanging Knees, 6 Bolts in each, or 6 Bolts to each Beam through the Side of 15 Inches long, and thro' the Beam, 3 to each of 1 Ft. 10 Inches long, there being 19 Beams, ſo that the Bolts are 114 of 15 Inches long, and 57 of 1 Ft. long and 10 Inches, which in all is 171 Ft. or 347 pound, by a Bolt of $\frac{7}{8}$ Diameter.

Standers 2 pair, 6 Bolts in each of 18 Inches each Bolt, is 36 Ft. of Inch Bolt, or 95 pound and a half.

Ring Bolts and Eye-bolts, with 10 Laſhing Bolts, is 54 Ring-bolts, with Rings of 20 Inches Circumference, and Eyes of 8 Inches Circumference, the Bolt is 9 Inches, which, for the Number of Bolts, is 166 Ft.

Forty-four Eye-bolts of 11 Inches Eye and 9 Inches Bolt, is 73 Ft. in all is 239 Ft. or 485 pound.

To Sum up,

	l.
Orlop	88
Gun-Deck	347
Standers	95 $\frac{1}{2}$
Port-Bolts	485
Total	1015 $\frac{1}{2}$

	c.	*q.*	*l.*
Which is	9	0	7 $\frac{1}{2}$

Stoper-bolts; 14 by 1 Inch Bolt, the Ring is 18 Inches, Eye 9 Inches, the Bolts 11 Inches, which together is 38 Foot and a half, or 102 pound.

	l.
Rings	2 $\frac{3}{4}$
Forlocks	1 $\frac{3}{4}$

Ports 22, Hinges 44 by 2 . 5. ſo then there is a 2 Inch Bolt and a qr. to each Hinge, which for 44 Hinges is 566 pound.

Port-hooks by the Weight require a $\frac{7}{8}$ Bolt, 44 of 7 Inches and a half each. Its 78 pound $\frac{3}{4}$.

Two Shackles to each Port, which together ſhall be 3 pound, which for all the Shackles makes 66 pound.

	l.
Rings	$2\frac{1}{2}$
Forlocks	$1\frac{1}{4}$

One Breaſt-hook under the Bowſprit having 10 Bolts by a $\frac{7}{8}$ of an Inch, the Length of each is 18 Inches. Its 15 Foot or 31 Pound.

Fore and Main Partners 16 Bolts of 12 Inches long, by a Bolt of $\frac{5}{8}$ of an Inch Diameter, which is 16 pound $\frac{3}{4}$.

	l.
Rings for Breaſt-hooks	$1\frac{1}{2}$
Forlocks	$1\frac{1}{4}$

Quarter-Deck and Fore-caſtle Knees 20, Beams 20, with 6 Bolts to each Knee, the Sum is 120 Bolts, being 60 of 10 Inches, and 60 of 12 Inches, which is 110 Ft. by a $\frac{5}{8}$ Bolt, which is 114 pound $\frac{3}{4}$.

Rings 80. or 7 pound.

Port-bolts for 6 Ports,, 12 Ring-bolts of 1 Ft. 10 Inches long, its 22 Ft. and 12 Eye-bolts of 12 Inches, which in all is 34 Ft. by a $\frac{3}{8}$ Augre, which is 35 pound and a half.

Strings in the Waſte, 40 Bolts of half an Inch Diameter, Length 5 Inches each; its 117 Ft. or 11 pound

Rings 40, or 2 pound and a qr.

Strings in the Great Cabbin, 28 Bolts by $\frac{5}{8}$ Diameter, Length 9 Inches; its 21 Ft. or 21 pound 3 qrs.

Rings 28, or 2 pound 6 Ounces.

Cat-head 10 Bolts by a $\frac{3}{4}$ Bolt, Length 12 Inches; its 10 Ft. or 15 pound.

Rings 10, or 1 pound and a qr.

To Sum up

	l.
Stoper-bolts	102
Hinges	566
Hooks	$78\frac{3}{4}$
Shackles	66
Breaſt-hooks	$16\frac{3}{4}$
Quarter-Deck Knees, *&c.*	$114\frac{3}{4}$
Port-bolts	$35\frac{1}{2}$
Strings	$32\frac{3}{4}$
Cat-head	15
Rings and Forlocks	$16\frac{1}{2}$
Total	1044

C. *q.* *l.*
112)1044 (9 1 8.
1008
36

Span Shackle Bolt Collar 2 Ft. and a half, Eye 1 Ft. Bolt 6 Ft. in all is 9 Ft. and a half of 1 Inch Diameter, which is 25 pound and a qr.

Rings half a pound. Forlocks 1 qr.

Top-tackle Bolts 2, of 3 Foot 8 Inches together by a Bolt of 1 Inch Diameter.

Eye-bolts for the Main and Fore Sheets 4, of 18 Inches long each, which is 6 Ft. of a Bolt of 1 Inch Diameter, being 9 Ft. 8 Inches, containing 25 pound and 3 qrs.

Ring 1 pound and a qr. Forlocks $\frac{5}{8}$ of 1 pound.

For the Top-ſail Hallyards, 2 Bolts of 18 Inches each.

Bolts for the Clue Garnets, 4 of 18 Inches each.

Bolts for the Tackles, 6 of 18 Inches each.

Bolts for the Horſes, 3 of 18 Inches each.

Bolt for the Mizon-Sheet 1, and all of them by a Bolt of $\frac{7}{8}$ of an Inch Diameter, they meaſuring 24 Ft. containing 48 pound.

Rings 2 pound and a qr. Forlocks 1 and a qr.

To Sum up

	l.
Span-ſhackle-bolt	25 $\frac{1}{4}$
Top-tackles	25 $\frac{3}{4}$
Rigging-bolts	48
Rings and Forlocks	6 $\frac{1}{8}$
	105 $\frac{1}{8}$

I ſhall make a particular Calculation for the ſmall Ships Main and Fore-chain Plates, which to ſize from the large Ships requires divers Conſiderations; as firſt, the Area's of the Maſts are as 6 to 1, and the Length but as 2 to 1; the Power or Sail is as 4 to 1, and ſo the Strain may be expected to be, and alſo the Security requiſite. The Breadth of the Channels are as 2 to 1, and conſequently the Proportion of ſhortning will be found there, notwithſtanding the Strength endwiſe will be equal to the Area contain'd in the Species, tho' the Strain cannot be abſolutely conſider'd in that Senſe, but ſomewhat between a bending and a ſtretching Strain: I ſhall therefore allow theſe Chain-plates to be equal to two Inch Bolts, and be meaſured by the Breadth of the Channel, which will then be in Proportion to the great Ships Plates near as 4 to 1; ſo that here is contain'd in the Ten Chain-plates (which is the Number ſuitable for a ſmall Ship of the Size I am mentioning) 25 Foot of Inch Bolt, which contains 66 pound and a half, the 10 Bindings will be 3 Ft. each by an Inch Bolt, which will be 30 Ft. containing 80 pound, which being put to the Plates will be 146 pound and a half.

The Chain-bolt to be ſized from the Square of the Diameter of the large Ship's Plates and Bolts, then theſe Bolts will be 1 Inch $\frac{1}{8}$, the Number will be 10 of 1 Ft. Length each, and the Head 4 Inches and a half, which in all is 13 Ft. 9 Inches, containing 46 pound and a qr.

Channel-bolts 10 of 28 Inches long by $\frac{3}{4}$ Bolt, is 23 Ft. 4 Inches, containing 35 pound.

The Bolt to compoſe the Fore-Chain-plates ſhall be as the Square of the Diameter of the Maſts are one to another, ſo is the Square of the Diameter of the Bolt, which will then be $\frac{7}{8}$ of an Inch, that the Meaſure is 20 Ft. and a half, containing 42 pound and a qr.

The Bindings will be 2 Ft. and half each, which will be 20 Ft. containing 41 pound and a half, which being put to the Weight of the Chain-plates, is 83 pound and a half.

Chain-bolts for the Fore-Channel 8, of 12 Inches long each, the Head 4 Inches, then the whole Length will be 9 Ft. 8 Inches, containing 25 pound and a half.

The Fore-Channel Bolts 8 of 2 Ft. 4 Inches each, which will be 17 Ft. 8 Inches, by a Bolt of $\frac{5}{8}$ Diameter, the Content of which will be 18 pound and a qr.

For the Mizon-Channel 6 Plates on both Sides compoſed with a Bolt of $\frac{4}{8}$ Diameter, the whole Length will be 10 Ft. containing 10 pound and a half.

The Bindings 5 Inches each, which will be 10 Ft. and a half, containing 11 pound, which being put to the Plates is 21 pound and a half.

I will allow that the 4 Back-ſtay Plates, with Stools, ſhall be equal in Weight to 4 of the Mizon Chain-plates, which is 14 pound and a qr.

The Bolts for the Mizon Chain-plates, and the Back-ſtay Plates will be 10 of 8 Inches long, which will be 6 Ft. ¾ compoſed of a Bolt ¾ of an Inch Diameter, which contains 10 pound.

Mizon Channel and Stool-bolts 10, by half Inch Bolt, and 18 Inches long each, which in all is 15 Ft. containing 10 pound.

For 6 Back-ſtay Plates in the Channel, 4 of 16 Inches by a ⅝ Bolt, and 2 of 16 and a half by a ⅝ Bolt, which together is 18 Ft. for the Plates, and 10 Ft. and a half for the Bindings, which together is 28 Ft. and a half, containing 29 pound ¼ and 6 Bolts of 1 Ft. each, by ¾ Diameter, which will be 9 pound.

Shackles through the Channels (to hook the Tackles) of 3 pound each, being 8 of them, containing 24 pound.

To Sum up,

	l.
Main Chain-Plates	146 ½
Bolts	46 ¼
Channel-bolts	35
Fore Chain plates	83 ½
Bolts	25 ½
Fore Channel-bolts	18 ¼
Mizon Chain-plates	21 ½
For Stools and Bolts	19
Channel and Stool-bolts	10
Ten Back-ſtay Plates	43 ¾
Eight Shackles	24
Total	473 ¼

C. q. l.
112(473¼ (4 0 25
448
25

I proceed to the Calculation of the Iron-work of the Rudder, &c.

The Weight of the Wood in this ſmall Rudder will be 14 *c.* 1 *q.* 0 *l.* then the Weight of all the Iron will be 3 *c.* 2 *q.* 24 *l.*

	C.	q.	l.
For 4 Braces	2	0	7
For 5 Pintels	1	1	27
For the Gudgeon	0	0	28

	l.
Then for each Brace will be	57 ¾
For each Pintel	35 ⅖

The Rudder at the lower Part will be 3 Ft. broad, and 8 Inches thick, which is 7 Ft. 4 Inches about.

Then each Brace will be equal to as much 2 Inches and ¼ Bolt, as will girt the Rudder at the lower End.

And each Pintel will be equal to as much Inch Bolt and 5/16 of an Inch as will girt the Rudder after the ſame manner.

And the Gudgeon equal to near as much Inch Bolt of the ſame Girt.

The Gooſe-neck (if any) will be 18 pound and half; the Cleat, with the Bolts, will be 5 pound and a qr, and for Hoops and Plates, and Bolts for the Head of the Rudder 66 pound, a Ring-bolt 5 pound, Bolts to faſten 58 pound, and to be divided as the Tunnage of one Ship is to the Tunnage of the other Ship.

The whole Weight of the Iron-work for the Rudder is 5 *c.* 0 *q.* 4 *l.* ½.

For the Head 26 Ft. of 1 Inch $\frac{1}{16}$ Bolt for the Knee, which contains 77 pound; then for the Gripe a Bolt of $\frac{11}{16}$ of an Inch Diameter, which will contain 27 pound.

For Cheeks Bolts of $\frac{11}{16}$, containing 56 pound.

For Lynings Bolts of $\frac{11}{16}$, containing 160 pound.

For Timbers, Knees, Beams, Brackets and Horſes, 55 pound.

	C.	*q.*	*l.*
Total for the Head, ——— ——— ——— ———	3	1	11
For the Stern Quarter-Pieces and Badges ——— ———	1	3	0

I ſhall allow this ſmall Ship only one Lantern, as Cuſtomary, which ſhall be 2 Ft. and a half Diameter, and Height agreeable to that; the Area of the Circle is 4 Ft. 5 Inches, the Weight of the Crank is 42 pound, which will be equal to 11 Ft. of 1 Inch and $\frac{3}{16}$ Parts of an Inch Bolt; however, by the way of Query, it ſeems ſomewhat odd, that the Weight of the Lanterns ſhould be as 8 to 1, and the Weight of the Iron as 28 to 9, or near as 3 to 1, the Length is as 2 to 1, and ſo is the Area; that the Bolt is of equal Strength, and will bear a Lantern of the ſame Weight with the biggeſt, provided the Lantern will ſtand in the ſame Compaſs as the ſmall Lantern will; but the Diſtance from the Strain is as 2 to 1, though the Weight is as 8 to 1. I ſhall therefore allow the Strength of the Bolt to be as 4 to 1, which will be near a Bolt of $\frac{5}{8}$ Diameter; then 11 Ft. of a Bolt, whoſe Diameter is $\frac{5}{8}$ of an Inch. will be 11 pound and a half for the Weight and Dimenſions of the ſmall Ship's Crank.

Bolts for the Scarphs of the Keel 15, of 11 Inches long each, being 13 pound 3 qrs, by a Bolt of 3 qrs Diameter, containing 20 pound and a half.

Bolts for the Stem 5 Bolts by a 3 qrs Augre, the Length 10 Inches each, which is 4 Ft. 2 Inches, containing 6 pound.

For the Tranſums 3 Bolts, 2 Ft. each, which will be 6 Ft. of a $\frac{3}{4}$ Bolt, containing 9 pound,

For the Main Capſtern,

		l.
Iron Hoops for Partners	——— ——— ———	13 $\frac{1}{8}$
Ribs	——— ——— ———	10
Whelp Bolts	——— ——— ———	40
For Chocks	——— ——— ———	18 $\frac{3}{4}$
For the Head	——— ——— ———	17 $\frac{1}{4}$
For the Toe	——— ——— ———	3
For Palls	——— ———	33 $\frac{1}{2}$
Hoops and Sawcer	——— ——— ———	40 $\frac{1}{4}$
For the Head	——— ——— ———	7 $\frac{1}{2}$
Rings and Forlocks	——— ———	1 $\frac{3}{4}$
		184 $\frac{2}{8}$

	C.	*q.*	*l.*
Total	1	2	15 $\frac{2}{8}$

The 2 Palls for the Windleſs will require to be of double Length to the Palls of the Capſtern, and conſequently double Length will require double Bigneſs, ſo that the Weight will be 4 times more, or 134 pound.

Bolts for the Bitts 12, of 18 Inches long by the Size of a 3 qrs Bolt, they being in all 18 Ft. long, contains 27 pound.

Bolts to go through the Cheeks 2 of Inch Bolt, 3 Ft. long each, is 16 pound.

Rings 1 pound and a half.
And Rings 2 pound 6 Ounces.
Forlocks 2 pound 2 Ounces.

To make a Total Sum of the ſmall Ships Iron-work.

For the Floor and to the Tranſum Knees, obſerving that the Floor-Timbers are 40, for 20 of which I allow the Bolts to be 3 Ft long, and 20 at 6 Ft. long, allowing alſo for the dead Wood; then there is 180 Ft. of Bolt, at 2 pound each Ft. which is 3 *C.* 0 *q.* 24 *l.* —— ——

	C.	*q.*	*l.*
Then —— ——	3	0	24
And —— —— ——	6	0	26
For Orlop, Gun-Deck, *&c.* —— ——	9	0	1 ½
Then to the Quarter-Deck ——	9	0	19
Then to the Mizon Chain plates ——	4	0	25 ¼
	31	3	11 ½
For Rudder and Tiller —— ——	5	0	4 ½
For the Head —— —— ——	3	1	11
For the Stern —— —— —— ——	1	3	00
For Scarphs of Keel, Stern and Tranſums ——	0	1	7 ¾
For a Lantern Crank —— —— ——	0	0	11 ½
For Capſtern and Windleſſes —— ——	3	1	26 ⅜
Rings and Forlocks —— ——	1	2	3 ⅜
Total	47	1	20

The Total Sum for this Ship's Iron-work, is 2 *Tun.* 7 *C.* 1 *q.* 20 *l.*

And ſo I paſs on to make ſome uſeful Obſervations on the Weight of Iron-work; but firſt ſhall juſt ſet down the Weight of Rings and Forlocks, which may be ſuitable to belay the Bolts for theſe ſeveral Services.

	Rings.	*Forlocks.*
	l.	*l.*
For Floor-Riders, and the firſt Article —— ——	35 ¾	18 ¾
For Orlop, Gun-Deck and Standers —— ——	25	9
For Port-bolts —— —— —— —— ——	16	8
Quarter-Deck Bolts —— —— —— ——	2	1
Main Chain Bolts —— —— —— ——	4	2
Fore Chain Bolts —— —— —— ——	3 ½	1 ¾
Mizon Chain Bolts and Stools —— —— ——	2	1
	88 ¼	41 ½
	41 ½	
	129 ¾	

	C.	*q.*	*l.*	*Ounces.*
In all is	1	0	17	4

Then the Method which I ſhall allow very agreeable to find the Weight of Iron-work, ſuitable to the Tunnage of the Ship, will be as follows.

Firſt the Proportion of the Iron-work ought to be from the Size and Proportion of the Wood, or at leaſt the Weight of the Wood, which to make general you may produce it from the Tunnage of the Ship, provided ſuch a Property was regularly found, which I preſume is not. However, I ſhall allow of it to make this Calculation, to find a general Proportion for the Weight of the Iron-work, but then you are to obſerve the

Number of Decks there is in one Ship more than there is in another, and ſubſtract that out of your general Calculation; as for inſtance,

	Tuns.
Firſt Rate, or a Ship of	1767
Second Size, or	1459
Third Size, or	1094
Fourth Size, or	650
Fifth Size, or	370
Sixth Size, or	261

	Tuns.	C.	q.	l.
The Iron-work in the Firſt Size is	32	12	0	26¼
And ſince the ſecond ſized Ship's Iron-work will be very little Different from the firſt, I allow the Iron-work directly from the Tunnage, which will then be	26	17	0	10
The third ſiezd Ship has a middle Deck leſs than the 2 firſt Sizes, which muſt be deducted out of the Proportion rom the Tunnage	20	9	0	12
	2	8	0	0
	18	1	0	12
The large Ship's middle Deck Iron-work is	3	17	2	20
The third ſized Ship's Middle Deck Iron-work would be if ſhe had ſuch a Deck	2	8	0	0
Then the third ſized Ship's Iron-work will be	18	1	0	12
The fourth Rates, or ſized Ship's Proportion will be beſt found from the third Size, her Number of Decks being near equal, according to her Bulk; then the fourth ſized Ship's Iron work will be	10	14	0	0
The fifth ſized Ship's Iron-work will be beſt found from the fourth, their Accommodation being pretty near equal. Then the fifth ſized Ship's Iron-work will be	6	14	0	0
The ſixth ſized Ship's Iron-work will be beſt found from the fifth, only ſhe has a Deck leſs, otherwiſe the Accommodations are near equal. Then a fifth ſized Ship's Upper Deck would require 11*C.* 0*q.* 0*l.* And if the ſixth ſized Ship had an Upper Deck, the Iron work requiſite to faſten it would be leſs. Then for a ſixth ſized Ship, from the Tunnage of the fifth, her Iron-work would be	4	13	0	0
	0	11	0	0
	4	2	0	0
But a ſixth ſized Ship's Iron-work, according to a nice Calculation of the Parts in her to faſten, is but	2	8	1	17¼
	4	2	0	0
	1	13	2	10¼

So that it appears by this Calculation that the Tunnage gives the ſixth ſized Ship 1 *Tun.* 13 *C.* 2 *q.* 10 *l.* ¼ more than what ſhe reaſonably can require, and conſequently all the others may have the ſame extraordinary Allowances, and therefore I ſhall try to adjuſt this Branch by the exact Weight of the Ships at their light Draught of Water, when nothing is in them, but what is applied to the building Part of the Ship, as you will find particularly made out in my *Ship-Builder's Aſſiſtant*, and then the Weight of Iron will be directly agreeable to the Weight of the Timber.

I found by divers nice Tryals as follows,

	Tuns
That the firſt ſized Ship weighs — — —	2008
The ſecond Size — — — —	1419
The third Size — — — — —	960
The fourth Size — — — — —	584
The fifth Size — — — — —	329
The ſixth Size — — — — — —	170

	Tun.	C.	q.	l.
The firſt ſized Ship's Iron will then be — —	32	12	0	26¼
The ſecond ſized Ship's Iron will be — —	23	11	0	0
The third ſized Ship's Iron will be — — —	15	0	0	0
The fourth ſized Ship's Iron will be — —	9	14	0	0
The fifth ſized Ship's Iron will be — — — —	5	10	0	0
The ſixth ſized Ship's Iron will be — — — —	2	17	0	0

Which is ſtill more than our particular Calculation by 9 hundred Weight, and therefore it muſt follow, that the Iron allowed for the ſmall Shipping, according to the Weight of their Timber's Scantling, is ſomething too large.

The whole Weight of Rings for belaying the Bolts of a Ship of 1767 Tuns, will be 15 *c.* 3 *q.* 18 *l.* and the Forlocks will be 4 *c.* 0 *q.* 24 *l.* Weight.

Then I proceed to a general Calculation for the Weight of the Iron-work.

To find the Weight of Iron-work from the Cuſtomary Tunnage, firſt, for a Ship of 3 Decks, multiply the Tunnage by 1 . 9, for all three Deck Ships that meaſure more than 1500 Tuns; that is, × the even Number of hundred Tuns by 1 . 9; as for Example,

Let a Ship's Iron-work be required, that meaſures 1769 Tuns, × 17 by 1 . 9 it's 32 *T.* $\frac{4}{10}$ of a Tun, or 6 Hund.

17 or × 1769 by 1 . 85, it's the ſame.
1.9

153
17

32.3

1769
1.85

8845 32 $\frac{7}{10}$ or 14 Hund.
14152
1769

32.7265

Then let another Ship of 1459 Tuns Iron-work be required, × 14 by 1 . 7, it's 23 Tuns and $\frac{8}{10}$ or 18 Hund.

Or × 1459 by 1 . 64 it's near the ſame

1459
1.64

14
1.7

5836

98 One is 23 Tuns $\frac{8}{10}$, the other 23 . $\frac{92}{100}$. 8754
14
1459

23.8

23.9276

For a two Deck Ship's Iron-work, let it be one of 1094 Tuns, × 10 by 1 . 5, it's 15 Tuns; or × 1094 by 1 . 38, it's near the ſame.

1094
1.38

10
15

8752 One is 15 Tun, the other is 15 Tun $\frac{9}{100}$ 150
3282
1094

15.0972

Let a two Deck Ship's Iron-work be requir'd of 650 Tuns, × 6 . 50 by 1 . 5 it's 9 Tuns 14 Hundred.

6.50
1.5
———
3250
65
———
9.750

Let a two Deck Ship's Iron-work be required of 370 Tuns × 3 , 70 by 1 . 5, it's 5 Tuns 11 Hundred.

3 . 70
1 . 5
———
1850
37
———
5 . 550

Let a one Deck Ship's Iron-work be required of 261 Tuns, × 2 , 61 by 1 . 0, it's 2 Tuns 12 Hundred.

From which it appears, that all two Deck Ships have for every hundred Tuns, they meaſure one Tun and a half of Iron put into them; which Quantity will ſuffice to faſten all the Wooden Work that is to be fixed in them.

And for every hundred Tuns any 2 Deck Ship meaſures, you may allow 1 Tun and ½ of a Tun of Iron-work to be put into them, and ſo in Proportion for the odd Number.

And for every one Deck Ship you may allow, for every hundred Tun ſhe meaſures, one Tun of Iron, which will be ſufficient; and for every 20 Tuns, 4 hundred Weight, and ſo on Proportionably, according as a Ship meaſures.

And theſe Calculations will be very agreeable to find the Weight of the Iron Work in general; Nay, by this Method you may find every particular Part; for ſince you ſee what one Ship's Part is in every Particular, as I have inſtanced, in the preceding Work, either the Weight, or the Size of every Piece of Iron in a Ship proper to connex her Parts, you may proceed and ſay, As the Weight of any Ships Iron Work is to their Ships, which I have mentioned in the general, ſo will the Weight of every particular Part be one to another, according to the Uſe and Place they are to be applied to, either for Timbers, Riders, Knees, or any other Part whatever it be; and having the Dimenſions of the Parts, you may know exactly what the Number of Pounds will be to every Part, with the Weight and Number and Size of the Rings and Forlocks, ſo that any indifferent Workman may exactly ſize his Iron-work in one Country, and apply it to Uſe in any other Country or Place whatſoever.

In the following Work I ſhall fully ſhew the Reaſon for being ſo very Particular in the Calculations preceding, and how vaſt Sums may be ſaved to the Owners of Shipping, provided they have any certain Number of Ships, that their Sizes are one under another, as I ſhall amply inſtance in the following Scheme; but firſt ſhall ſet down a few Articles in relation to the Reparation of Iron in the Publick Service, and what I found in the Smith's Contract, *viz.*

Article I. For new ſetting a Chain-plate, or a new Neck made to it, or for Binding an old Collar on a new Dead-eye, Value 8 *d.*

Obſervation on Article I. Though there are two included at one Price, how agreeable they may be, I in ſome meaſure refer; but am apt to believe it will chiefly fall on the ſmalleſt ſized Ships, and that ſuch Parts in them will be often in Repair.

Article II. For the Righting or Pointing a Crow, Clench-Hammers mended at any End, Fid's ſharpned, Pick-axes mended at any End, Wedges mended at the ſmall End, Marlin-ſpikes mended, Cuts, Shuts, and Rights, and for either of theſe Particulars, the Value is a Penny.

Obſervation, The firſt of theſe ſeems much out of Proportion to the laſt, and notwithſtanding I am poſitive, that an indifferent Workman may earn 10 *s. per* Day, the Fire and waſte of Tools incluſive.

But as to Cuts, it's really extravagant, ſince it generally falls upon ſmall Work, as Augre-ſhanks, and the like, which a Man may cut faſter than any Smith could make Four Penny Nails, when he finds Iron, and yet ſells 20 for a Penny.

Article III. For ſhutting a Crow, mending Fids at the great End, and alſo mending Wedges at the great End, Value 2 *d.*

Obſervation. Theſe Articles are much out of Proportion to the preceding ones; and yet I am apt to believe, that the Smith would never make a Contract to loſe by it.

For new clawing Crows, Value 5 *d.*

Article IV. For opening and ſhutting the Neck of a Chain-plate, and mending double Headed Mauls at one End, Value 3 *d.*

Obſervation. That theſe are good round Prices, but not to compare to thoſe which go before.

The Fifth and Grand Article, which I ſhall more fully conſider, and make an Explanation of is, That the Smith at the Rebuilding or Repairing of any Ship generally allows the Owners 13 *s. per* Hund. for all the old Iron that is drove out of her; and that if the Owner will have any Iron new wrought, and ſtand to the Waſte of it himſelf, he ſhall pay the Smith 18 *s.* for every hundred Weight that comes from the Forge, of which Properties I ſhall particularly mention as follows.

You may obſerve in my Calculation of reducing ſquare Bars into round Bolts, the Value of Coals, Labour, and uſe of Bellows, Anvil and Hammer, is not worth above 5 *s. per* Hundred Weight Forging, and that is from a Bolt of 2 Inches Diameter, to one of half an Inch Diameter; and therefore if any Perſon deſires to have his old Iron wrought, being three times the Labour of what the Value will be to work new Bars, it's really very unreaſonable, and ſuch Management by all Men of Skill will be allowed to be very Prepoſterous.

However, it will certainly appear otherwiſe, if rightly conſider'd, and ſuch Management may be complied with, to the Advantage of the Owner, eſpecially in Buſineſs, where a large Number of different ſized Ships belongs to one Owner, as it undeniably doth in the Publick Service, in Building and Rebuilding the Royal Navy; and in that particular Caſe I ſhall conſider it, that is, in the ſix ſized Ships belonging to the Publick, termed firſt, ſecond, third, fourth, fifth, and ſixth Rates, the Size of whoſe Bolts are in the following Proportion, *viz.* $1\frac{9}{16}$, $1\frac{7}{16}$, $1\frac{3}{8}$, $1\frac{1}{4}$, $1\frac{1}{16}$, and $\frac{3}{4}$, then dividing 2 Inches into 32 Parts, the Proportion is,

25 These Sizes are the principal Bolts belonging to thoſe ſix
23 Ships, and what may guide us towards this important Po-
22 } 32 Parts. ſition, which is purely to ſhew, that by a good and proper
20 Method, duely put in Practice, all Iron-work for ſuch a
17 large Number of Ships, may be ſucceſſively tranſmuted, and
12 fitted from one Ship to another, with very little Waſte.

The Difference in the Diameter, between the firſt Size and the ſecond, is $\frac{2}{32}$ Parts of an Inch, and between the ſecond and third $\frac{1}{32}$ Parts of an Inch, and between the third and fourth $\frac{2}{32}$ Parts of an Inch, and between the fourth and fifth Size $\frac{3}{16}$ Parts of an Inch, and between the fifth and ſixth Size $\frac{3}{4}$ Parts of an Inch, which Diminution is from $\frac{3}{8}$ to $\frac{1}{4}$ Waſte more than what any Bolt will waſte in 20 Years, if a Ship lyes dry, with an Allowance for new working included, and therefore with Care and ſuch a Method as I ſhall deſcribe, a firſt Rate's Iron will ſerve for a ſecond Rate, after it has laſted in her 20 Years, and after the ſame manner, a ſecond Rate's Iron will ſerve the third Rate, the third Rate's the fourth, and the fourth Rate's the fifth, and the fifth Rate's the ſixth.

Now the common Practice is quite different, ſince at any Ship's being pull'd to Pieces, the Bolts are drove out and laid in a confuſed Heap, and ſo perplex'd, as if they never were to be brought to any material Uſe again; and ſo perhaps in a Year, or ſome ſuch a Time according to the Fancy of the Managers, this Iron-work, which is little inferiour to new Bolts; nay, in ſome meaſure better, according to the Snbſtance it will hold, ſhall be ſold to the Smith, or ſome other Truſty Chap, for 13 *s. per* Hundred Weight, or 112 pound. The Smith juſt beating the Ruſt off, perhaps cold, or otherwiſe a little warm to colour the ſame as new, not charging him above 5 *s. per* Hundred in the Medium throughout the whole Ship, which being put to 13 *s.* is 18 *s.* which Sum is the very outſide Charge the Smith is at, and then he ſhall have 32 or 33 *s. per* Hundred for it again, ſo that he makes 14 or 15 *s. per* Hundred clear Gains, all his Charge and Trouble included.

Then provided that a firſt Rate Ship has 32 *Tun.* 12 *c.* 0 *q.* 26 *l.* $\frac{1}{2}$ of Iron-work, that muſt be applied to faſten her Work, and that the Value of the ſame may be rated at 32 *s. per* Hundred, then the prime Charge will be 1043 *l.* 11 *s.* 5 *d.* and that a ſecond Rate having 23 *Tuns* 11 *C.* of Iron, the Value at the ſame Rate will be 753 *l.* 12 *s.* And a third Rate having 15 *Tun.* the Value will be 480 *l.* A fourth Rate having 9 *Tun.* 14 *C.* the Value will be 103 *l.* 8 *s.* And a fifth Rate having 5 *Tun.* 10 *C.* the Value will be 176 *l.* And a ſixth Rate having 2 *Tun.* 17 *C.* the Value will be 91 *l.* 4 *s.* which Sums put together, is 2854 *l.* 15 *s.* 5 *d.* the Value of the Iron-work required to build one of each Rate, from a firſt to a ſixth Rate Man of War. I ſhall only at preſent × 2854 *l.* 15 *s.* 5 *d.* by 100, though the Number of Shipping in our large Navy is 250 of every ſort. Notwithſtanding I ſhall do in this, as in all other Caſes, rather allowing my Calculations mean, than any ways to an Extream one way or another, giving room for great Waſte and Remiſsneſs in Duty; then the Total Sum for finding Iron for an hundred Sail of Ships, from one of 1700 Tuns, to one of 250 Tuns, will be 285477 *l.* 8 *s.* which Sum I allow much inferiour to the Charge of what Iron-work will be new fitted with a very ſmall Waſte, and may with good Management be put into the Ships again.

Then provided that by what Method I have and ſhall deſcribe, there may be ſaved 10 *s.* out of every 30 *s.* which is one Third of the Sum, although I am almoſt certain there may be 12 or 13 *s.* ſaved, according to ſuch a Calculation, out of every 30; but ſtanding faſt to 10, then that will be 6 *s.* 8 *d.* in every Pound, which Proportion for the whole Sum as aforementioned, will be 95159 *l.* 6 *s.* and provided that this ſame Quantity was to be drove out, over-haul'd and new fitted every 17 Years, there would be ſaved 5597 *l.* every Year; but indeed it's moſt general at this Time to ſee Ships haul'd to Pieces at the Age of 14 Years, and if ſo, there will be 6997 *l.* ſaved every Year, and the Buſineſs as well, or rather better perform'd than it ever was. The Rules and Methods for doing of which, with the different Charge that will happen in laying the Iron away methodically, that it may be and fit to be uſed again; and in continuing the preſent Method of laying it apart ſo very confuſed, that it's not only impoſſible to iſſue it out for proper Uſe again, but alſo to know whether it be all ſaved and preſerved for the Owners Uſe and Service.

I ſhall therefore ſtate the Caſe thus, that 30 Men may be imployed to pull a Ship of 1700 Tuns to pieces, and from thence ſhall allow the Number of Men, according to the reſpective Tunnage, for any other Ship, or otherwiſe, according to the Weight of their ſeveral Parts.

Tunn. of each Ship.	Square of Pieces.	Area of the Parts.	Leng. Gun-Deck.			The Areas are one to another as
1703	$19\frac{1}{2}$	380	170	Second to firſt ſized Tunnage	is as 6 to 7	7 to 8
1459	$18\frac{1}{4}$	333	165	Third to firſt	is as 7 to 11	11 to 16
1094	$16\frac{3}{4}$	280	150	Fourth to firſt	is as 7 to 18	15 to 29
667	14	196	130	Fifth to firſt	is as 3 to 14	3 to 8
370	12	144	106	Sixth to firſt	is as 2 to 13	6 to 19
261	11	121	96			

The Lengths of the Ships are one to another as		Then the Compound Fractions of the Length and Area will be
	Second to firſt as 31 to 32	$\frac{31}{32}$ of $\frac{7}{8}$ × is $\frac{217}{256}$ or $\frac{6}{7}$
	Third to firſt as 7 to 8	$\frac{7}{8}$ of $\frac{11}{19}$ × is $\frac{77}{120}$ or $\frac{2}{11}$
	Fourth to firſt as 10 to 13	$\frac{10}{13}$ of $\frac{15}{29}$ × is $\frac{150}{377}$ or $\frac{2}{5}$
	Fifth to firſt as 5 to 8	$\frac{5}{8}$ of $\frac{3}{8}$ × is $\frac{15}{64}$ or $\frac{7}{30}$
	Sixth to firſt as 4 to 7	$\frac{4}{7}$ of $\frac{6}{15}$ × is $\frac{24}{133}$ or $\frac{10}{55}$

Then the Number of Men which will be ſuitable to pull a Ship of the ſeveral Rates to Pieces in equal time, as well as 30 Men will pull the largeſt Ship to Pieces, will be

Second Size	26	Men.
Third Size	19	Men.
Fourth Size	12	Men.
Fifth Size	7	Men.
Sixth Size	5	Men.

I could never obſerve that reaſonable Men would ever refuſe to do any thing that was reaſonable, and therefore I am abſolutely perſwaded that in pulling any Ship to pieces, there needs no other Help than the Shipwright to take care of the Bolts; and as they are drove out to talley them, and faſten them together, returning them to the Cabbin-keeper appointed for that purpoſe, that they might be as well adapted to the proper Service again, as the Running Rigging of a Ship is when it's unreeved in order to unrig, to refit and make the ſame Rigging do again, with every Inch of Rope that they find ſerviceable.

But however, I will allow the Charge of two Labourers and a Cabbin-keeper (which is generally an old decay'd Ship Carpenter) conſtantly attending the Service, whoſe Wages together will be 60 *l.* a Year; and this Conveniency to be allow'd in every Yard that belongs to the Publick, which will be 5, than 5 times 60 is 360 *l. per Annum*, which Sum I am poſitive will over-do it; but I'll allow enough, and then there would be yearly ſaved above 5000 Pounds a Year in this one Material.

Notwithſtanding I am poſitive there will be great Objections againſt this beneficial Propoſal, and one of the moſt material will be, that no Smith would undertake to comply with ſuch Management, ſince its plain and obvious, that this ſaid Part in the Smith's Contract is his chiefeſt Gain.

But to that I ſhall reply in the old Phraſe, that the World was never ſo dull, but if one won't another will, ſince there be Hundreds very ingenious Smiths in *England*, that would be glad of a far worſe Imployment than this, and would readily comply to do this Part upon meaner Terms than any that I have mention'd.

For firſt as to Day Work, I am very poſitive if there was a firſt Rate to be haul'd to pieces, and at the ſame time a ſecond Rate to be built, then two Smiths would be able to alter this Work, and ſhape it new, as faſt as 40 Shipwrights Labour would require it to be done, and their Sallary at 2 *s. per* Day would not amount to above 70 *l.* a Year, provided they were to Work ſome extraordinary Hours on occaſion.

The Forty Men as Shipwrights would build a Ship of 1400 Tuns in 15 Months, and then the Smith's Work would be 87 *l.* 10 *s.* for the whole Building, if two Smiths were to be conſtantly employed upon ſuch a Ship's Iron-Work, and to do nothing elſe, and then the Workman's Wages would be 4 *s. per* Hundred; tho' by my former Calculations I hint that 5 *s. per* Hundred will pay the Workman, find Coals, and all other Conveniencies; which ſaid 5 *s.* in every Hundred will really do, and therefore two Smiths cannot be born out conſtantly in new working Iron upon the biggeſt Ship in *England* (provided you put her out of Hand in Proportion to the Time of 15 Months, which I allow for building a Second Rate) and doing the whole Buſineſs that is to be done in Iron from the Forge, ſince there will be abundance of Intervals between bringing the Wood together and faſtening of it with Iron, as in the firſt beginning, after a few Bolts are made for the Scarphs of the Keel, Stem, and Stern-poſt, and the Floor Timbers bolted on to the Keel, and alſo the Kelſon faſt, it may be 6 Months before any Material Bolts be wanting, and yet the 40 Men ſhall be conſtantly employed, and then comes on the Work which requires Bolts in faſtening of the Decks, notwithſtanding there will be ſeveral other Intervals in building of the Ship.

But perhaps another Objection may be ſtarted, that if one or two Journeymen Smiths be employ'd, there will alſo want a Maſter to direct, otherwiſe the Work may be ſlighted, or the Men not kept cloſe to their Buſineſs.

But why not in Smith's Work as well as in Brazier's or Plummer's Work, where one or two of a ſort is employ'd in every Yard, only to mend a few Furnaces and Copper Chimneys: That undeniably the Charge of a Brazier is much more than can be thought reaſonable, or what the Value of the Work can poſſibly come to, and much more than what it might be done for by the Lump; which brings me to conſider how all Smith's Work in Shipping may be more nicely adjuſted and done by the Lump.

And firſt I would have every Ship's Iron Work nicely calculated and ſized, both as to the Quality and alſo to the Quantity, and then the old Bolts at their driving out may be immediately put in the Fire and new wrought to what Size they will hold, and laid by againſt the Occaſion.

To have very nice tryals for ſizing the Augre to the Bolt, that the Ship-Builder and Smith may jump exactly together in the Gauge, which will enable the Smith ſucceſſively to provide his Iron before it be wanting, and to proceed without having any Hinderance.

To weigh the Iron to the Smith, expecting the ſame Weight back again, only allowing of a reaſonable Waſte, the Quantity of Coals delivered to the Smith, according to the Weight and Faſhion of the Iron; and when any wilful Waſte ſhall appear, the Smith to bear the Damage, and not the Owner. The Anvils, Hammers, and all neceſſary Utenſils to be charg'd to the Smith, and where any Loſs ſhall happen, the Smith to make it good.

But here muſt be another Block remov'd before this Branch, or cuſtomary Scheme can be changed, which is to the working of new Iron, where our ſaid old Sizes of Iron will not ſuit; however, I ſhould think it no hard Matter, nor material Objection, ſince any Underſtanding Purveyor may as well provide Iron for Building of a Ship as he can Wood, and with as much Frugality, or rather more than what is in common Uſe.

Notwithſtanding if it ſhould prove too hard for an able and experienc'd Purveyor to provide Iron ſuitable, which I am poſitive would not (ſince thoſe Men of all other are the moſt General, and on Occaſion will be Joyner, Calker, Cooper, Plummer, Smith, nay any thing that has the leaſt dependance on any Branch of Ship-building) why then, there may be Hundreds of Smiths in *England* both able and willing to undertake the new Iron Work, and be wholly excluded from having any thing to do with the Old, and ſo I ſhall paſs on to ſome other Conſiderations of the Nature of Work which is bought by the Piece, according to the Temper and Faſhion of it, call'd Praiſed Work, in which I ſhall more particularly inſtance ſome Things which may more materially explain the Nature of the Smith's Buſineſs.

Firſt I ſhall begin with the Augre, and ſo go through ſome Part of the Edge Tools, which will lead me a plain Path to ſome other Conſiderations of another Nature.

The Augre is an Inſtrument of ſingular Uſe and Service in Ship-building, and ſo very fitly adapted for compoſing the ſame, that if ever any Perſon was Deify'd for Inventing, I ſhould highly recommend the Author of an Augre deſerving of that Glory. To what a Pitch its improved, and the Perfection it's brought to, ſhall not at preſent be the Subject of my Inquiry; but only of the Difference there generally is in ſuch Inſtruments, and the Diſadvantage which may accrue through ſuch a Diverſity in the Goodneſs of the Augre.

Firſt I will ſet down the Size and Price of common Augres from 2 Inches Diameter to ½ an Inch Diameter, right Ingineer Bitts, that the Smith will oblige himſelf to change if they prove not very good.

Inch.	*Inch.*	*Inch.*	*s. d.*	*d.*	*Inch.*	*Inch.*
Diameter of the Augre in Inches and Parts.	Circumf. of the Augre	Area of the Hole.	Price of the Augre-Bitt.	Price of Turning the Bitt up and new faſhioning it	Length of the Bitt.	Thickneſs of the Bitt.
2 0	6 3/10	3 3/20	3 0	6	10	2/10
1 3/4	5 1/2	2 42/100	2 8	6	9 1/4	3/16
1 1/2	4 7/10	1 75/100	2 6	6	8 1/2	1/8
1 1/4	3 9/10	1 22/100	2 4	4	7	1/8
1 1/8	3 1/2	0 98/100	2 0	4	6 1/4	3/16
1 0	3 3/20	0 78/100	1 10	4	6	3/16
0 7/8	2 3/4	0 60/100	1 8	3	5 3/4	1/4
0 3/4	2 7/20	0 44/100	1 6	3	5 1/2	3/16
0 5/8	1 97/100	0 31/100	1 4	2	5 1/2	1/8
0 1/2	1 58/100	0 20/100	1 2	2	5 1/4	1/10

And theſe are the Dimenſions and Prices of Ingineer Augres; but as to the Price of the Augres for Publick Service in the Yards, they are lumped from a two Inch Augre to a half Inch Augre, at 2 *s.* each Bitt; it is therefore plain without Spectacles, that ſome good Husbandry appears, by only obſerving theſe Calculations, ſince the ſmalleſt Bitt in it is near that Price, and the largeſt a great deal more, and the middlemoſt full as much; from which it's plain, that if an equal Number of the ſeveral ſized Augres were uſed and wore out in the Publick Service, and that ſuch common Augre-bits were full as good as what is term'd true Ingineer Augre-bitts; then the Providers would be really right, and ought to be highly commended for their Care; of which I am to conſider in the next Place.

And firſt from Experience I ſhall inſtance how long a right good Ingineer Bitt may ſerve a Workman in Building and Rebuilding Ships on new Work; and not only from my own Experience, but by very good Information, I do find that a good Augre well made and carefully look'd after, may laſt a Man Seven Years; nay, twice Seven, if it comes to no Caſualty by boring againſt Iron and the like; and in ſuch a caſe, if it be bitted, it's but 4 *d.* or 6 *d.* according to the Variety of the Sizes, to turn it up and new faſhion it again: So that it may be very modeſtly allowed, that one Augre of any of the aboveſaid Sizes may laſt a Man Seven Years; the Sizes being 10, which together will coſt 20 *s.* then the Charge of Augres to furniſh 10 Men Seven Years will be 20 *s.* and to find Augres for 500 Men will be 50 Pounds; and this Calculation will be ſuitable, if the Bolt Holes in any Ship were as many as the Trenel Holes, which are not ſcarce as 1 to 10; ſo that the Charge of finding Augres for the Bolt Holes for the Uſe of 500 Men, will not be above 10 Pounds, and very probably may continue good Seven Years, without doing any thing to them.

The ſecond Seven Years, which reaches to the Period of 14 Years, I only allow the Augre to be turned up, which is to add the Charge of turning the Bitt up and new faſhioning of it to the firſt Price, which in moſt Augres will be ⅓ of the Prime Coſt; however, I will allow the ⅓ of the firſt Coſt to be added to the Price, which will then be 3 *l.* 6 *s.* 8 *d.* to be added to 10 *l.* and then the Total Charge will be 13 *l.* 6 *s.* 8 *d.* and the next 7 Years, which will reach to the Period of 21 Years, I ſhall allow the like Sum of 3 *l.* 6 *s.* 8 *d.* to be added to 13 *l.* 6 *s.* 8 *d.* ſo that with timely and ſeaſonably new faſhioning the Augre, they may continue a Man's Age; but I ſhall only allow of 42 Years Duration, and then the Charge of Augres to ſerve 500 Men 42 Years will be 26 *l.* 13 *s.* 4 *d.* but inſtead of ſuch a Charge, its very probable the Charge may be according to the preſent Cuſtom; as I ſhall endeavour to explain in the following manner.

Beginning firſt and allowing that a Ship of 70 Guns, or a Medium Ship may be built in 50 Weeks with 40 Men, allowing each Man 20 *s.* a Week, I have obſerved that 3 or 4 of the common Augres has been ſpoiled one after another, without doing any manner of Service, ſome of them being too hard, but moſt too ſoft, which cauſes them to twiſt, and is a common Defect in ſuch Inſtruments, none coming up to the Goodneſs of the right Ingineer Augres, whoſe Price I have mention'd by near as 2 to 3; ſo that the Price ought to be again leſſened, according to the Difference there is in the Species.

I ſhall again allow, that 20 of ſuch common Augre-bits ſhall be wholly ſpoiled in the Building of one Ship, tho' I am apt to believe it is far ſhort of what is really ſpoiled in ſuch Mongrels, and very defective Augre-bits; and after ſuch a Calculation, there will be 250 Augre-bits ſpoiled every Year amongſt 500 Men, which at 2 *s.* a Bit is 12 *l.* 10 *s.* and in 42 Years will be 525 *l.* That the Loſs or Difference will be near 500 *l.* in 42 Years in the working of 500 Men; but I fear I am full ſhort in charging the juſt Value for finding and uſing ſuch Materials; I heartily wiſh that 4 times the ſame may comply to do that Service, which will more particularly appear by the Receipts and Eſtimate Books where ſuch Goods have been formerly uſed, and ſo I proceed to ſhew the Unreaſonableneſs of allowing a ſet Price for Augres, eſpecially to give 2 *s.* or 2 *s.* 2 *d.* for each, one with another; and after calculate ſome Tables of the Price, from a Conſideration of a true and exact Mixture in every Augre-bitt, and from the Bulk and Faſhion of the ſame.

It muſt not nor cannot be denied, that there is at leaſt 13 Augres uſed (in Ship-building to bore Bolt Holes) from 1 Inch Diameter downwards to one Augre-bitt that is uſed accordingly from 1 Inch upwards; nay, of 2 Inches very ſeldom, except in faſtening the Knee of the Head in great Ships, and to 1 Inch and a half Diameter from 2 Inches Diameter, only to bore Holes for Chain-bolts, beſides the Firſt and Second Rates together is not above $\frac{1}{14}$ of the Number of the Third, Fourth, Fifth, and Sixth Rates, and in Repairs according to the Uſe, which is not above one half of the others Uſe, which two Fractions being $\frac{1}{7}$, I am abſolutely perſwaded the extream Sizes of Augres ought to be an Inch and $\frac{1}{4}$ Augre, and a half Inch Augre; ſo that the middle Size will then be an Augre of $\frac{7}{8}$ of an Inch Diameter, the Value of which I ſet at 1 *s.* 8 *d.* each, inſtead of 2 *s.* each, or 2 *s.* 2 *d.* and this is provided the Mongrel-bitts were brought to a true Mixture, ſince I am poſitive at preſent, one true Engineer Augre will be moved twice as faſt with equal ſtrength; from which Faculty the Mongrel-bitts ought to be valued but at half what the others are, which will then be but 10 *d.* each, not one half of what at preſent is given for the ſame; but proceeding from gueſs-work, I ſhall paſs on to calculate ſome Tables, for the Price of the true and well temper'd Augres, only I ſhall firſt mention ſomething which may be of Uſe in ſuch Proportions to guide me right.

I have obſerved that the Length of the Pod in an Inch Augre, and half an Inch, is 8 Inches and a half long; but knowing that ſome of that Size is too apt to twiſt, and allowing that ſuch twiſting is cauſed by ſuch extraordinary Length, provided the Augre is made of a true Mixture; I ſhall therefore allow the general Length of the Pod to be 5 Diameter and a half of the ſaid Pod or Bitt at the lower End: But the Length of the Pod in an Augre of ¾ of an Inch Diameter, is now 5 Inches and a half long, which is above 7 Diameters of the Pod at the lower End.

Now the Strength requiſite in an Inch and a half Augre, and in one of ¾, is as 4 to 1, tho' the Diameter is as 2 to 1; for the Area of the Hole is as 4 to 1, and conſequently the Reſiſtance is the ſame, for the Weight of the Core is as 4 to 1; the Diameter of the Augres is as 2 to 1, and ſo is the Circumference, that the Thickneſs of the ſame muſt be alſo agreeable as 2 to 1, to make them equally ſtrong with equal Length.

The thickneſs of the 2 Augres mentioned will be alſo 12/44 of the Pod's Diameter, and be perfectly Circular, or a ſmall matter Eliptical; but for the nice Shape, I ſhall rather refer it to come amongſt the Engineer Work in Ship-building, and ſhall proceed to calculate ſome Tables, allowing the Pods to be of equal Length, and afterwards ſhall calculate others, wherein I ſhall allow the Pods Length to be 5 Diameters and a half.

The Firſt Table.

Diameter of the Pod. *Inch.*	Equal length of the Pod *Inch.*	Thickneſs in Parts of an Inch to make them equally ſtrong with equal Length.	5 Diameters and ½ of the Pod, which I allow to be a ſizeable Length for the Augre *Inch.*	Thickneſs ſuitable to the Length of 5 Diameter and ½.	Areas of Pore in Inch. & Part *Inch.*	Value according to Weight of Metal from a Proportion of the Area of the Hole with equal Length. *s.*	*d.*	Value of turning up or new-faſhioning with equal Length according to Area & Diam. *d.*
2 0	8 ½	46/100	11	60/100	3 3/20	3	9 ½	8
1 ¾	8 ½	4/10	9 ⅝	45/100	2 42/100	2	9	7
1 ½	8 ½	34/100	8 ¼	33/100	1 75/100	2	0	6
1 ¼	8 ½	28/100	6 ⅞	225/1000	1 22/100	1	4 ¾	5
1 ⅛	8 ½	25/100	6 3/16	183/1000	0 98/100	1	1 ½	4 ½
1 0	8 ½	23/100	5 ½	158/1000	0 73/100	0	10 ¾	4
0 ⅞	8 ½	20/100	4 13/16	114/1000	0 60/100	0	8 ¼	3 ½
0 ¾	8 ½	17/100	4 ⅛	82/1000	0 44/100	0	6	3
0 ⅝	8 ½	14/100	3 7/16	56/1000	0 31/100	0	4 ½	2 ½
0 ½	8 ½	11/100	2 ¾	35/1000	0 20/100	0	2 ¾	2

The Second Table, or the Continuance of the Firſt.

Whole Value of the Augre-bitts, with Pods of equal Length. *s.*	*d.*	Price of the Metal when the Pod is ſhortned to 5 Diam: and ½, and of ſizeable Thickneſs to an equal Length. *s.*	*d.*	The Value of the Metal when the Length is 5 Diameters, and ½ the Thickneſs ſuitable to the ſhort Length *s.*	*d.*	Whole Value of the Bitt when the Length is 5 Diameters, and ½ Thickneſs ſuitable to an equal Length. *s.*	*s.*	Whole Value of the Bitt, when Length is 5 Diameters and ½, with Thickneſs ſuitable to that Length. *s.*	*d.*
4	5 ½	4	11	6	5	5	7	7	1
3	4	3	1	3	4 ½	3	8	3	11 ½
2	6	1	11 ¼	1	10 ½	2	5 ¼	2	4 ½
1	9 ¾	1	10 ¼	0	11	1	6 ¼	1	4
1	6	0	10	0	7 ¼	1	2 ½	0	11 ¾
1	2 ¾	0	7	0	5	0	11	0	9
0	11 ¾	0	4 ¼	0	2 ¾	0	8 ¼	0	5 ¾
0	9	0	3	0	1 ½	0	6	0	4 ½
0	6 ¾	0	1 ¾	0	1	0	4 ¼	0	3 ½
0	4 ¾	0	1	0	1 ¼	0	3	0	2 ¼

And after ſuch a manner may every individual Material be brought to general Prices, whether they are of one Sort of Metal, or of divers Mixtures; altho I am almoſt Poſitive that our Iron-mongers will ſtand mute to ſee their Secret unriddled, and to have it made plain without the Help of Perſpective Glaſſes, that better Goods may be purchaſed for half the Money than has been publickly given for them; but fearing ſome will be Querying, I ſhall endeavour to illuſtrate and make obvious this Matter, and explain the Calculations a little farther.

And firſt for the Price and Value of the Metal, which I have allowed to be according to the reſpective Weight, as believing if the Metal be a true Mixture, and that the ſame Sort be put to compoſe one Tool, as is put to compoſe another, according to their ſeveral Sizes, nothing can adjuſt that Part nicer, ſince a Pound, or any other quantity of Metal equally refin'd with a Pound, or an equal Quantity of the ſame Sort in every reſpect, then ſuch two equal and alike Quantities of Metal in Goodneſs and Weight, muſt be alſo directly equal in Price and Value.

Then as to the faſhioning Part, I have allowed the Value to be in Proportion to the ſuperficial Content, though I am apt to believe ſome will reflect and ſay, That a ſmall Augre, or other Inſtrument's faſhioning, will be as difficult as a large one, and conſequently as Valuable; but if ſo, Why ſhould not a Two-penny Nail Gimlet have Six-pence allowed for faſhioning of it, as well as an Inch and a half Augre, ſince they are of the ſame Species, though of uuequal Bulk? And if ſo, pray what is allowed for the Iron that makes the Gimlet? And in ſeveral other Caſes may be brought divers Inſtances, which would prove the Incompatibleneſs of the ſame, or that it ſhould be at all reaſonable for a ſmall Material to have as much allowed for making of it (or faſhioning of it) as is allowed for making a larger of equal Fineneſs and Neatneſs.

Upon the whole I ſhall allow the Smith for his Encouragement the Advantage in the Length of the Augres, which ſhall be for ſome ſmall matter of extraordinary Trouble he may pretend to have in mixing the Metal for ſmall Work in Proportion to great, according to the Price allowed him.

So that I will allow the Price of all Augre bitts to be reaſonable below an Inch and a half Diameter, according to the equal Length of 8 Inches and a half, and leave the Smith to make what Advantage he can between the Length of 8 Inches and a half, and the Cuſtomary Lengths, ſince the Thickneſs that I ſhall ſet down, will be ſuitable to the Faſhion of making, and the Uſe, which I ſhall more particularly deſcribe in the following Figures; but firſt I ſhall calculate Tables of the Size and Value of Augres, from 2 Inches Diameter to half an Inch Diameter.

Diameter of the Pod at the lower End.	Equal Length of the Pod, or Bitt.	Length of the Pod, or Bitt, as Cuſtom.	Thickneſs of the Pod or Bitt in the middle of it	Price of the Augre-Bitt.		Value of Turning them up and new faſhioning them.
Inch.	*Inch.*	*Inch.*	*Inch.*	*s.*	*d.*	*d.*
2 0	8 $\frac{1}{2}$	10	$\frac{60}{100}$	6	0	8
1 $\frac{3}{4}$	8 $\frac{1}{2}$	9 $\frac{1}{4}$	$\frac{45}{100}$	3	2	7
1 $\frac{1}{2}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$	$\frac{34}{100}$	2	6	6
1 $\frac{1}{4}$	8 $\frac{1}{2}$	7	$\frac{28}{100}$	1	9 $\frac{3}{4}$	5
1 $\frac{1}{8}$	8 $\frac{1}{2}$	6 $\frac{1}{4}$	$\frac{25}{100}$	1	6	4 $\frac{1}{2}$
1 0	8 $\frac{1}{2}$	6	$\frac{22}{100}$	1	2 $\frac{3}{4}$	4
0 $\frac{7}{8}$	8 $\frac{1}{2}$	5 $\frac{1}{4}$	$\frac{20}{100}$	0	11 $\frac{3}{4}$	3 $\frac{1}{2}$
0 $\frac{3}{4}$	8 $\frac{1}{2}$	5 $\frac{1}{2}$	$\frac{17}{100}$	0	9	3
0 $\frac{5}{8}$	8 $\frac{1}{2}$	5 $\frac{1}{2}$	$\frac{14}{100}$	0	6 $\frac{3}{4}$	2 $\frac{1}{2}$
0 $\frac{1}{2}$	8 $\frac{1}{2}$	5 $\frac{1}{4}$	$\frac{11}{100}$	0	4 $\frac{3}{4}$	2

And theſe are the Dimenſions and Prices, which I believe will be found very reaſonable for all Augre-bitts, between one of 2 Inches Diameter, and one of half an Inch Diameter, and from which Calculations, and what I have mentioned before, it will plainly appear, that this Part of the publick Materials may be provided for half what it has been done for, and the Tools be much better both for diſpatching of Buſineſs, and for the longer Duration; but referring ſuch Matters to be nicely looked over by thoſe that are over Curious, and deſiring to ſee the Difference, which I preſume will be found to be very wide.

I ſhall only ſet down a plain Mechanical way to ſhape an Augre, and paſs on to conſider the Nature of other Materials.

In the Figure *A.* let *f. f. d.* be the Diameter of the Augre. Deſcribe a Perpendicular Line *a. d.* then divide the Semicircle *f. d.* into 11 equal Parts, take one of thoſe Parts, and ſet from *d.* to *c.* then with the Extent of a Semi-Diameter, ſtrike out the Arch *f. a. f.* which will be the Circumference of the Augre-Pod. Divide from *a.* to *c.* into 10 equal Parts, and at 5 and a half from *a.* let be the Thickneſs of the Augre-bitt in the Middle, then ſet off the Diſtance *a. d.* from *b.* to *e.* at which Center *e.* you may ſtrike out the Circle *f. b. f.* which ſhall be the ſhape of the Inſide of the Augre-bitt.

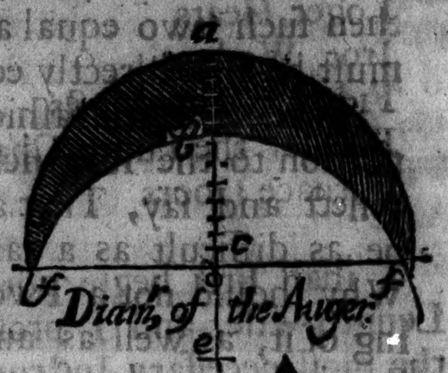


fig. A

Fig. B. You may obſerve in this Figure, that the Iron is thicker in the Middle from *a.* to *b.* becauſe the Mixture is not ſo good, there being more Iron than Steel, ſo that it will be more Ductile, and will bend much ſooner, and therefore the Managers are obliged to make them ſtiffer by an Addition of bad Metal; which is as well a Hindrance in filling up the Cavity that ſhould hold the Core, as in reducing that ſweet Temper, there will always be in a true Mixture of Steel, and the vaſt Difference as will certainly appear in a dull and blunt Edged Tool that is wholly compoſed with Iron.

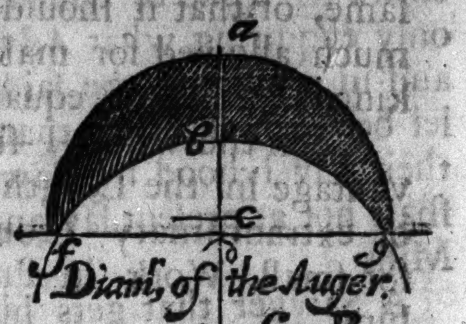
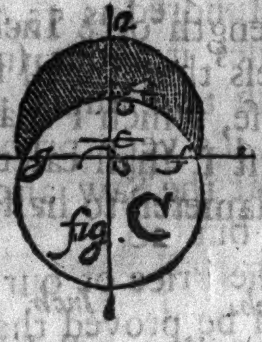


fig. B

I ſhall juſt mention ſome Materials of a ruder Nature, and explain them; though I ſhall in the Cloſe of this Obſervation mention every Material that is of Uſe to compoſe the Machine.



Species.	Price. s.	d.	
Pick-axes well ſteel'd	0	3 ½	per Pound.
Oven Lids	0	4	
Augre-bitts from half an Inch Diameter to 2 Inches Diameter	2	0	each.
Axes well ſteel'd, 11 Inches long and 3 Inches broad	2	4	
Cold Chiſſels 7 Inches long	1	0	
Clench Hammers	1	0	
Hack	1	0	
Hatchets well ſteel'd, 7 Inches long and 4 Inches and a half broad	14	0	per Dozen.
Pitch Pots	0	2 ½	per Pound.
Two Hand Saws, 48 Inches long	4	0	each.
Whip-Saws, 78 Inches long	7	0	
Hack-Saws, 34 Inches long	2	6	
Scrapers well ſteel'd	16	6	per Dozen.
Braſs Shivers	0	10 ¼	per Pound.
Lignum vitæ	0	5	
Iron Shivers may be for	0	2 ½	
Rowls for Pumps, Braſs,	1	1	

Double Head Mauls Loger Heats Iron Wedges Fids for Top-Maſts Fids for the Pump-Chain Furnace Doors	At the Price of Forged Iron.

I ſhall firſt begin with the Whip-ſaw, or an Engine to divide Timber Length-wiſe, and I profeſs I cannot tell whether the Saw or the Augre is the moſt neceſſary Inſtrument; but both are extraordinary Uſeful in Ship's Building, one for dividing and parting large Pieces of Timber into divers Pieces, the other for knitting and uniting ſeveral ſmall Pieces, to make one entire Machine or whole Ship; and as in the Augre, ſo in the Saw, I am only enquiring what Advantage or Diſadvantage may be made in the Choice, and in providing the ſaid Material; in doing of which I ſhall draw a Parallel between the Saws that are in common Uſe amongſt thoſe Men that make their Livelyhood by Sawing, and ſuch Saws as I here rate at 7 *s.* each, and ſhall not at preſent ſay any thing of the Frame-Saws, or of ſuch as are in Saw-Mills.

A Sawyer that gets his Living by Sawing, commonly purchaſes one Saw every 18 Months, which Saw (it's very likely) may cut 1000 Foot of Work every 12 Days, allowing the large Saw to do but half the Work which the Sawyer performs for his Living; then 40 Thouſand Foot of Work at 2 *s.* 9 *d.* *per* Hundred is 55 *l.* and then the Saw being well worn, and grown light, he uſes it about ſmaller Work till he earns half ſuch a Sum of 27 *l.* 10 *s.* which two Sums put together is 82 *l.* 10 *s.* and at the Expiration of that time it's very probable he will ſell the ſaid Saw for 10 *s.* a Rib he terms it; ſo that the Saw after he has uſed it to earn 82 *l.* 10 *s.* can be counted at Prime Coſt but 20 *s.*

The Price of our common Saws is 7 *s.* 6 *d.* which being but $\frac{1}{4}$ of 30, if it could be proved that ſuch Mongrels were as uſeful as the true and well mixed Saws, there would be rare good Husbandry practiſed in providing them; however, I ſhall conſider of that as follows:

Firſt, I obſerved when my Father was Maſter Carpenter of ſeveral Men of War, and being allowed ſuch Mongrel Saws for his Sea Store, they become no other than as Paſſengers, as being of no Uſe or Service; but that a good Hand-ſaw was far better for diſpatch. The ſame I experienced my ſelf when I was Maſter Carpenter of ſeveral Men of War, that let what Pains there could be taken to Whet and Set ſuch Saws, they would do no manner of Service, but were wholly Uſeleſs.

But to ſhew the Defect more particularly, if they are Iron and not a true Mixture, they muſt be made much thicker, which will be both a hinderance to the diſpatch, and alſo waſting to the Material; as for inſtance, let a true well mixed Saw be $\frac{1}{8}$ of an Inch thick, and an Iron Saw $\frac{1}{4}$, ſince according to the Nature of Iron (and alſo the Uſe) they cannot be leſs; beſides, by the Rudeneſs of the Make, they will not run in a leſs Carf than $\frac{1}{4}$ of an Inch, provided they are obtained for 7 *s.* 6 *d.* So that the Reſiſtance of the Mongrel Saw, and one of a true Mixture, will be as 2 to 1; that inſtead of earning 82 *l.* 10 s. there will be but 41 *l.* 5 *s.* earn'd, and by conſequence the like Sum loſt by uſing the Iron Saws; then allowing that in cutting ſuch a Quantity of Work as I have before mention'd, which will be 6000 Foot on the Superficies, the Carf or Waſte by the true mixed Saw will be but 622 Foot; but in the other Saw it will be juſt as much more, or 1244 Foot of Work: That by ſuch Mongrel Saws there will be 622 Foot of Timber clearly loſt in the Uſe and Duration of ſuch a Material, which 622 Foot I allow as converted Timber, ſince it will be waſted out of the middle or better Part of the Tree; then converted Timber at a Medium Value will be

5 *l. per* Load, tho' perhaps it may be a great deal more. However, at that moderate Value it will be upwards of 60 *l.* ſo that by the hindrance of the Artificer, and Waſte made by the Material, there will be 101 *l.* 5 *s.* loſt by the Wear and Difference of ſuch Inſtruments; however, that's not all yet, ſince the Number of Saws worn out to cut ſuch a Quantity of Timber will be as 4 to 1 at leaſt; that is, there will be at leaſt 4 of the Mongrel Saws filed to Pieces and wore out, to one of the mixed Saws, and perhaps not an equal Quantity of Timber ſplit and divided by each; nay, perhaps according to the Sample as I have obſerv'd in the Iron Ware, not half the Quantity of Timber converted, and yet the Number of Saws worn out ſhall be four times as many; ſo that at the Expiration of Years allowed for the Wear of ſuch Goods, the Charge of providing Iron Saws will be much dearer than if there were Steel Saws uſed, and the Loſs ſuſtained by uſing the Iron Saws full as much as what I have here inſtanced.

But perhaps ſome will ſay, that the Saws which are allowed to the Carpenters of the Publick Ships are but very ſeldom uſed, and when they are, there's no Stint of Time, ſo that in ſuch a Caſe there will be no ſuch over good Saws required. Indeed I am of the Opinion, if there is no Uſe for them, they may be well left in the Iron-mongers Shop, and the Charge of 150 or 200 Saws ſaved, at 7 *s.* 6 *d. per* Saw, and therefore I ſhall conſider of the Uſe a little farther.

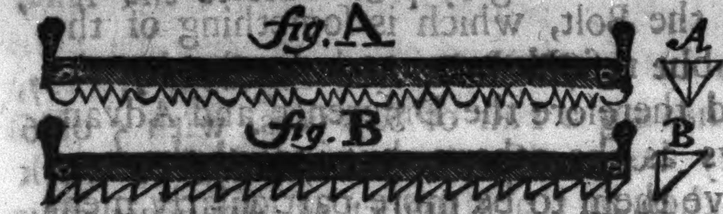
The Carpenter's Stores for the Sea Service conſiſts of divers Species, as Plank, Deals, Elm, Board, and the like; of which Materials may be converted divers others of a leſſer Denomination, which muſt be either parted with a Saw or an Axe; but the Saw will be highly preferable to the Axe, eſpecially if it be a good one.

Again, if a Ship ſhould happen to be at *Virginia*, *New England*, *Norway*, or in any ſuch Timber Country, and having a Pair of Sawyers, with 5 or 6 good Shipwrights on Board, and they being alſo provided with Iron work convenient and neceſſary for Repairs, then ſuch a Number of Artificers may do as much Work for 50 *l* as in *England* would coſt 100 *l.* That in ſuch a caſe it would be highly neceſſary for ſuch Ships to have good Saws on Board, preſuming that ſuch Saws of a true Mixture, after they have ſerved a Sawyer a Year and a half, may make a Ship's Saw during her whole Reign, or at leaſt the cuſtomary Duration of 17 or 18 Years, and the Charge or Value of ſuch Saws will be at moſt but 15 *s* each, which for 200 Sail of Ships will be but 150 *l.* And after ſuch a manner might be con'd over the Charge of every Utenſil that would be uſeful and proper to ſerve any Ship as long as ſhe continues, or at leaſtwiſe to the Expiration of any certain Number of Years; and of conſequence the Total Charge for finding the Wear of any Number of Ships, may be moſt exactly found. But I paſs on to the Croſs-cut Saws, which are of a more general Uſe amongſt Ship-builders than the Whip-ſaws are, ſince the Difference is thus: The Whip ſaw is diſtinctly uſed by a particular Set of Men call'd Sawyers, but the Croſs-cut Saws are uſed at every Turn, in almoſt all the Jobbs which are performed by the Shipwrights, and therefore the Advantage in ſuch Saws ought more particularly to be the Subject of our preſent Conſideration; and in doing of it, I ſhall firſt inſtance ſomething of the Nature of ſingle Hand-ſaws, which Shipwrights term Hand-ſaws, (and the Croſs-cut-ſaws are term'd Two Hand-ſaws) one Sort being generally uſed with one Man's Labour, and the other by Two Men. Indeed there is ſcarce one Artificer belonging to his Function, if he conſiders either his own Eaſe or the diſpatch of his Buſineſs, but will have a good Set of Tools, and alſo well ordered, before he pretends to enter into a ſtrange Place, where he is not known; ſince the firſt Onſet commonly gives the Perſon his Character, either one way or another; but more particularly if a Man Works for his own Advantage, or to Lump his Work, he will be ſure to have good Tools, for it gives Life and Vigour to his Performance, eſpecially to have a right good Hand ſaw and Augres, ſince of all others they are really the Principal for diſpatching Ship-work.

A right good Hand-ſaw of true Mixture will coſt 6 or 7 *s.* and indeed one of ſuch a Price will part Timber by Croſs-cutting of it as exact as it can be ſet with a Level and Square, and mark'd out with a Pair of Compaſſes, provided they are nicely ordered; beſides, ſuch Saws are very durable, and with good Uſage will laſt a Man's Age, or at leaſt-wiſe 40 Years, which I take to be the Time that moſt Men will perform a Day's Labour.

The Iron Saw is perhaps juſt touch'd with ſome better Mettle next to the Teeth; ſo that at the beginning of the Wear you fancy you have got a Rarity, until you have Whet him half a Score times, when he becomes little other than Iron, and of no Uſe or Service; and it's very probable, that a Man may Wear out 4 or 5 of ſuch Mongrels, whilſt another Man may do more Work with one Saw that is of a true Mixture; beſides, the Diſadvantage and Waſte will be according to my preceeding Obſervation of the Nature of a Whip-ſaw; which brings me to a Conſideration of the Croſs-cut Saws in the Publick Concern.

The Price of ſuch Saws you ſee is 4 *s.* which indeed is but ſmall, conſidering the Mettal that's put to make them, and the time requiſite, ſince a right good Saw of a true Mixture, and well ordered for Croſs-cutting Timber, will be well worth 20 *s.* I have obſerved in Trenel-makers, who have the only Saws for Croſs-cutting Timber, that one of their Saws will diſpatch ſuch Work to Admiration, I am poſitive 6 times more than our common Saws will, and alſo hold the Cut without Whetting Ten times longer.



The Faſhion of the Teeth are as in the *Figure* A Every Tooth in the ſaid Saws makes an Equilateral Triangle, or two right Angles; ſo that they run as efficacious one way as the other, which in my Opinion is the true and genuine Nature of Two-Hand Saws; for in employing Two Men, one Man is as ſerviceable as the other; whereof in the common Saws whoſe Teeth only make one right Angle, as in the *Figure* B. they Cut but one way; ſo that half the Stroke is loſt, or one Man's Labour in Two; by which means, without any other Conſiderations, our common Saw becomes 8 *s.* each; and in the next Place, as I ſaid before, there muſt be an Allowance of Mettal to make them ſufficiently ſtiff, which will be as 2 to 1, and then the Labour is again diminiſh'd one half, which will raiſe the Price to 16 *s.* a Piece; the Loſs in the Timber will be alſo as I ſaid before: But however, that is Lengthwiſe, and not minded; for as the Woman ſaid by the Flower, that's our own; but however one thing in ſuch Caſes ſhould be minded, to ſee the bad Performance by the Uſe of ſuch Materials, ſince I never could obſerve but that the Workman has as much to do with an Axe, or an Addice, after the Uſe of ſuch a Saw (from the Deficiency of it) as could be expected to Countervail, in the Time that would be taken up in uſing of a true and genuine Saw.

The Difference in the Duration will be according to my former Obſervation, ſince I will ſtate the Caſe thus: That there may be allowed in working 500 Men to an extream, that every Two Men ſhall have a Saw, then the Number of Saws will be 250 at 20 *s.* each, and ſuch Saws will laſt with good Uſage 40 Years; then the Value will be 250 *l.* to provide Saws for 500 Men 40 Years. On the other hand, let there be the ſame Number allowed of the Mongrel Saws at 16 *s.* each, which I plainly make appear they will coſt from the Deficiency of the ſame, then that Sum will be 200 *l.* So that there will be but 50 *l.* ſaved in 40 Years, provided the Iron Saws would laſt ſo long as thoſe of the true Mixture; but it's very plain and obvious to almoſt every Artificer, that they will not laſt a qr. ſo long; that there would be 800 *l.* expended on the Mongrels for 40 Years Service, and by conſequence 550 *l.* loſt in the ſaid Material in that time.

But perhaps ſome would object againſt having ſuch a Number of Saws allowed at one time; neither do I recommend it as expedient to have a bigger Number than what is really needful; however, the Calculation will be exactly uſeful in any other Number, let the Proportion be ever ſo various; and as good a way as any to ſee whether my Obſervation points to Advantage, is to mind whether 250 *l.* pays the Expence of Croſs-cut Saws for 40 Years, and for the Uſe of 500 Men, which will be 6 *l.* 5 *s.* a Year; then allowing our Mongrel Saws at 16 *s.* each (as I plainly make appear they will be by their Deficiency in the Uſe) you muſt have but 8 Saws at 4 *s.* each (which is the cuſtomary Price) to ſerve 500 Men 12 Months, or one whole Year: But to explain it a little farther; That 8 of the Mongrel Saws at 4 *s.* each, is but 32 *s.* at Prime Coſt; but in Conſideration of the Defect in cutting the Teeth, and in the Reſiſtance by the double thickneſs, they will increaſe the firſt Price (in the Wear of the Saw) 4 times; 4 times 32 is 128, or 6 *s.* 8 *d.* according to the Price as aforeſaid, and therefore the Charge of Croſs-cut Saws may be much better provided for the Uſe of 500 Men every Year for the Sum of 1 *l.* 12 *s.*

I paſs on now to the other Edge Tools, as Hack-ſaws, Cold-chiſſels, Clench-Hammers, Axes, Hatchets, and the like; all which would ſeverally bear a large Conſideration, but tending to the ſame purpoſe, and therefore I ſhall content my ſelf in making ſome ſmall Remarks on every one of them.

The Hack-ſaw is to cut Iron as in driving out Bolts, where they are ſet ſo faſt in the Hole that they bend, and will not ſuffer to be drove out, at which times the Hack-ſaw is applied to woory the Bolt and rub him aſſunder; and in this Caſe a Conſideration ought to be in the tempering, that the Mettal in the Saw ought to be Proof againſt the Bolt, which is ſomething of the ſame Nature, ſince the beſt of Steel is but refin'd Iron made harder by the Fire, as Pitch is produced from Tar, and therefore the Difference and Advantage will as plainly appear in ſuch Saws as the other; but indeed they are not of ſo general a Uſe, and I ſhall leave them to be more particularly mention'd in ſome other Place.

The Cold Chiſſels are alſo for cutting Iron, and ought to be Proof for hackling and conſuming the ſame; I have really obſerv'd a vaſt Difference in ſuch Materials, ſome of them that are well prepared will cut Iron to Admiration; but very few of them that are prepared for 12 *d.* a Piece, for of ſuch you may Hammer 10 or 12 to Pieces without doing of any manner of Service; and therefore all ſuch Goods ſhould be well proved, as to the intrinſick Goodneſs, as well as by an outward Appearance, and not to pay 12 *d.* for that which perhaps when brought to Uſe is not worth 1 *d.* conſidering the Goodneſs and Wear of ſuch an Inſtrument that may be purchaſed for the Price of 12 *d.*

The Clench-Hammers are much of the ſame Nature with the Cold Chiſſels, as being for Hammering and Working down Iron, and therefore ought to be rightly prepared, and if they were fitted with that deſign to do Service; I am ſure I have ſeen ſuch Goods very unfit for Service, ſo far, that when ſeveral have lain ready for Service, the Artificer has made Uſe of the Pen of his Maul to do that Service, which was incumbent on ſuch bad Goods that were no ways fitting for the deſigned Service.

I ſhall cloſe theſe Conſiderations with looking into the Nature of the Axe and Hatchet, which are Tools principally provided for the Uſe of the Sea Service, either for cutting of Rope or ſplitting of Wood.

An Axe fitting for a Shipwright's Uſe in Hewing is generally 12 Inches long, and 6 Inches and ¼ broad, or thereabouts, according to the Strength or Fancy of the Artificer, and ſuch an Axe is generally ſold for 3 *s.* 6 *d.* the Weight being near 3 Pound; the Area of the ſame is 75 Inches on the Superficies, and ſuch a Tool will laſt a Shipwright one Year, provided it be good, and no Accident happen to it, then at the Expiration of one Year, the Artificer new fits his Axe, that is, the Smith adds Steel to the Iron, which is call'd new Steeling the Axe, and then in all likelyhood (provided the Pole is good) it will laſt another Year; the Charge of Steeling being 2 *s.* 6 *d.* will make the whole Charge of the Axe 6 *s.* or 3 *s.* a Year for the Charge of that Tool; only allowing a Drawback of perhaps 6 *d.* for the Value of the old Tool as old Iron.

The Wood Axe is commonly 11 Inches long, and 3 Inches broad; the Superficial Area is 33, or ½ the Superficial Area of the Ship Carpenter's Axe; but the Price being 2 *s.* 4 *d.* is as 8 to 7, and the Area as 2 to 1. The Hatchet is 7 Inches long, and 4 Inches and a half broad; the Superficial Area is 31.5, the Price is 14 *d.* near as 3 to 1 to our common Ship Axes; from which is plain, that ſuch Tools are not ſold in direct Proportion of their Areas, ſince the Wood Axe and Hatchet's Area's are near as 2 to 1 with the common Axe that is well prepared for Ship-builders, and therefore the Price ought to be chiefly proportion'd from the Goodneſs and well Temper of the Mettal. However, I ſhall conſider the Duration of the ſame from the Time that our common Axes will laſt, and be conſtantly employed; I ſay ſuch Axes that are well and nicely prepared for Ship-builders, may be provided at the moſt for 3 *s.* a Year. Now ſuppoſing that a Workman may make (with his Axe) every Day one Day with another 500 Strokes, which will be 3000 every Week, and 156000 every Year, and all theſe Strokes with a Tool whoſe Price is but 3 *s.* 6 d.

The Uſe of a Wood Axe on Board of any Ship cannot be poſſibly ⅓ as much, ſince it's only provided for ſplitting Wood, or cutting of a Cable, and the like; and the Uſe of the Hatchet is only for cutting out Rigging, which Uſe is very inconſiderable to the Uſe of a Wood Axe amongſt hard Oak Knots, and in old Ships amongſt Bolts and Nails of Iron; ſo that the Charge of finding ſuch Materials on Board of any Ship, cannot be above half of the Price of one of each, which is 1 *s.* 9 *d.* a Year; and by ſuch Similies may be produced Rules to adjuſt the reaſonable Expence of every Material belonging to any Ship, barring Caſualties, which will be incident to all things; and ſo I proceed to conſider of the Value of ſome Iron Materials of a more ruder Nature.

The Pitch Pot you may obſerve is valued at 2 *d.* ½ *per* Pound, or 22 *s.* 4 *d.* *per* Hundred, and from whence I preſume may be adjuſted the Price of all Caſt Iron, or ſuch as is run from the Furnace, and produced by melting Iron Oar, or Mineral Subſtances, and the ſame is Caſt at the firſt heating into the Form in which it will be continued without any other Trouble of Amendment.

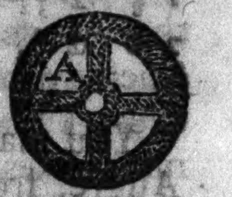
Now all forged Iron is ſuch as is hammer'd again after it is melted in the Furnace, and run out into Bar Iron; which double Trouble, and ſome other Intervals, as you may obſerve, ſet an extraordinary Value of 8 or 9 *s.* in every Hundred Weight, and yet the ſame but Iron ſtill, which indeed ought to put us upon ſome thought, what Iron Materials may be ſuitable with only being run from the Furnace, and ſuch ſhould be provided for the Owners Uſe, without any other additionary Charge, to ſave the extraordinary Expence that will be in Forging or Hammering the ſame.

Then to Particularize ſome of thoſe Materials that may be uſeful directly from the Furnace, I ſay the Iron Plates that are put under the Chain-pumps may be ſuch, all Top Plates, Ribs for Capſtands, Plates for Truſtle-trees, Sawcers for Capſterns; alſo the Iron Hoops that are put into the Steps of the Capſterns, the Loger Heats, and Fids to open the Pump-Chains, and I am of Opinion the Fids of the Top-maſt; but am unwilling to be poſitive before Tryal be made, fearing Danger, with abundance of other Utenſils belonging to Shipping, which may be as well perform'd with Caſt Iron; and altho' but a Half-penny or 3 Farthings in every Pound be ſaved, yet in ſuch a large

Quantity, which will be in a great Number of Ships, there would be a vaſt Sum ſaved in the Owners Expence every Year.

I am alſo of Opinion, that ſuch Caſt Iron might make Shivers for large Blocks as well as Braſs. The Difference is 8 *d.* in every Pound Weight; nay, it will be ſomething more, ſince Braſs to Iron is as 9 to 8 in Weight, and then the Iron Shivers may be made lighter than Braſs one Pound in every 9 Pound.

I ſay further, that if it was not for the extraordinary Weight in Iron Shivers, they would be purchaſed much cheaper than Lignum-vitæ Shivers; but the Weight, when Iron and Lignum-vitæ is of equal Bulk, is near as 6 to 1, or as 17 to 3. But in Shivers that lie low and near the Hull of the Ship, this can be no great Objection, notwithſtanding the Iron Shivers may be made ſo Artificial, that $\frac{2}{3}$ of their Weight may be reduc'd, as in the *Figure A.* where all the Space between the Bars may be Vacancies, and then the $\frac{2}{3}$ of 17 is 11 $\frac{3}{10}$, which from 17, remains 5 $\frac{7}{10}$, ſo that the Weight would be then as 5 $\frac{7}{10}$ to 3, which is not as 2 to 1; and from thence the Price would be leſs in the Iron than in the Lignum-vitæ, as Lignum-vitæ is 5 *d per* Pound, and Iron but 2 *d.* $\frac{1}{2}$ *per* Pound, and conſidering the Duration of Iron to Lignum vitæ, it ſhould not be a Thing void of our Care to look more nicely into it, ſince Iron is partly the Product of our own Soil.



If there ſhould chance to be an Objection, that Iron will ruſt ſooner than Braſs, and ſo become Detrimental to the Rope, and therefore is not proper for Shivers, I could anſwer, That there be ſeveral coarſe Fellows on Board of moſt Ship to look after them, and preſerve them from Ruſting, eſpecially for the larger Shivers, as Viol-Blocks, Sheet-Blocks, Cat Blocks, Jeer-Blocks, Top tackle-Blocks, and Top-maſt Shiver-Blocks, all which may be taken out, clean'd and put in again (without Prejudice to the Uſe) as Occaſion would permit.

I am Poſitive the Rowls under the Pump Chains may be made of Iron without any Objection and divers pretty little Conveniencies might be made for paſſing the Rigging clear one of another in hauling with Facility to the Purchaſe, all which Devices would not be ſo well faſhioned out of Lignum-vitæ, as out of Iron, nor made ſo cheap out of Braſs.

There is one Thing more which is very material in providing the Iron Utenſils, and that is, in Locks, and bright poliſh'd Work, that it ſhould never be purchaſed long before it be applyed to Uſe, ſince it will grow ruſty, and ſo become unſeemly and damnified. It's really very eaſy to calculate what the Charge and Number of Locks will be to ſerve any Ship, or any Number of Ships for any Number of Years; and that will be from the Number of Cabbins there is on Board of a Ship, and alſo from the Goodneſs and Fitneſs of the Locks, as to obſerve how long a good Lock will continue on a Houſe, with looking after it Carefully, and by timely repairing of it, when in Default, which will add mightily to its Duration; alſo the Latches, the Caſements, and every petty Utenſil when it lyes at a Perſon's own Charge to make the neceſſary Reparations, and to put others in the Places of thoſe that are damnify'd.

I proceed now to ſhew a Method to ſize the Augre to the Bolt, having before ſized the Augre to the Trenel, and giving ſome Reaſons for my Proceedings, and of the different Exceſs between the Bolt and the Trenel.

Inch.	Inch.	Size of the Bolt.
0 $\frac{1}{2}$	0 $\frac{17}{32}$	Parts of an Inch and $\frac{56}{100}$; or $\frac{1}{2}$ an Inch and $\frac{56}{100}$ Parts of $\frac{1}{8}$ of an Inch.
0 $\frac{5}{8}$	0 $\frac{21}{32}$	Parts of an Inch and $\frac{1}{20}$; or $\frac{5}{8}$ of an Inch and 2 $\frac{1}{20}$ Parts of $\frac{1}{8}$ of an Inch.
0 $\frac{3}{4}$	0 $\frac{26}{32}$	Parts of an Inch and $\frac{4}{10}$; or $\frac{3}{4}$ of an Inch and 2 $\frac{4}{10}$ Parts of $\frac{1}{8}$ of an Inch.
0 $\frac{7}{8}$	0 $\frac{30}{32}$	Parts of an Inch and $\frac{1}{4}$; or $\frac{7}{8}$ of an Inch and 2 $\frac{1}{4}$ Parts of $\frac{1}{8}$ of an Inch.
1 0	1 $\frac{3}{32}$	Parts of an Inch and $\frac{2}{10}$; or 1 Inch and 3 $\frac{2}{10}$ of $\frac{1}{8}$ of an Inch.
1 $\frac{1}{8}$	1 $\frac{7}{32}$	Parts of an Inch and $\frac{13}{20}$; or 1 Inch $\frac{1}{8}$ and 3 $\frac{13}{20}$ of $\frac{1}{8}$ of an Inch.
1 $\frac{1}{4}$	1 $\frac{12}{32}$	Parts of an Inch and ---; or 1 Inch and $\frac{3}{8}$ of an Inch.
1 $\frac{3}{8}$	1 $\frac{16}{32}$	Parts of an Inch and $\frac{9}{20}$; or 1 Inch and $\frac{1}{2}$ and $\frac{9}{20}$ $\frac{1}{32}$ Parts of an Inch.
1 $\frac{1}{2}$	1 $\frac{20}{32}$	Parts of an Inch and $\frac{7}{10}$; or 1 Inch $\frac{5}{8}$ and $\frac{7}{10}$ $\frac{1}{32}$ Parts of an Inch.
1 $\frac{5}{8}$	1 $\frac{25}{32}$	Parts of an Inch and $\frac{11}{20}$; or 1 Inch $\frac{3}{4}$ and 1 $\frac{11}{20}$ Parts of $\frac{1}{8}$ of an Inch.
1 $\frac{3}{4}$	1 $\frac{29}{32}$	Parts of an Inch and $\frac{7}{10}$; or 1 Inch $\frac{7}{8}$ and 1 $\frac{7}{10}$ Part of $\frac{1}{8}$ of an Inch.
1 $\frac{7}{8}$	2 $\frac{2}{32}$	Parts of an Inch and $\frac{3}{20}$; or 2 Inches and 2 $\frac{3}{20}$ Parts of $\frac{1}{8}$ of an Inch.
2 0	2 $\frac{6}{32}$	Parts of an Inch and $\frac{7}{10}$; or 2 Inches $\frac{1}{8}$ and 2 $\frac{7}{20}$ Parts of the $\frac{1}{8}$ of an Inch.

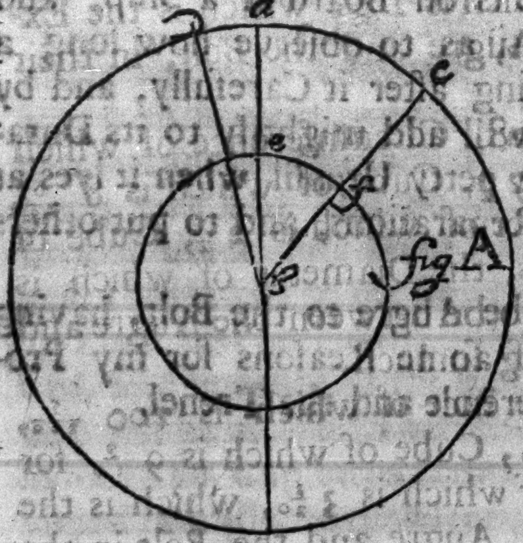
You may obſerve in theſe Calculations, that I have ſized the Bolt to the Augre, from a Bolt of $\frac{17}{32}$ Parts of an Inch, and $\frac{56}{100}$ of the $\frac{1}{32}$ Part, to a Bolt of 2 Inches and $\frac{6}{32}$ Parts of an Inch, and the $\frac{7}{10}$ of the $\frac{1}{32}$ Part, which are the Sizes that are generally uſeful in Shipwork, there being very ſeldom any Size bigger or leſs.

The Exceſs in the biggeſt Bolt is $\frac{6}{32}$ Parts of an Inch and $\frac{7}{20}$ of the $\frac{1}{32}$ Part of an Inch, which is near $\frac{1}{4}$, and the Exceſs in the ſmalleſt Bolt is $\frac{1}{32}$ Part of an Inch, and $\frac{56}{100}$ Parts of $\frac{1}{32}$ Part of an Inch.

But for a more clear Illuſtration of this Work, I ſhall ſhew the Method I took to make this Calculation, which was to divide the Inch into 32 Parts, and making that the Diameter, I find the Circumference ſuitable; than cubing the Circumference, I proceed to make a Diameter for the Common Exceſs between the Bolt and the Augre, which in an Inch and a qr. Bolt, is $\frac{1}{8}$ of an Inch, or $\frac{4}{32}$ Part. I then find the Circumference of the Exceſs, and Cube that; then I ſay, As the Cube-Root of the Circumference in one Bolt is to the Cube-Root of the Circumference in the other Bolt, ſo is the Cube-Root of the Circumference of the Exceſs in one Bolt, to the Cube-Root of the Circumference of the Exceſs in the other Bolt, beginning at 1 Inch and a qr. Bolt, where I fix the common Difference.

But for a clearer Explanation of the Fractions, I ſhall bring them nearer to our common two Foot Rules, only firſt ſhall lay down a plain Mechanick Method, to ſhow the Exceſs or Difference between the Bolt and the Augre.

In the *Figure A.* you may obſerve, that the Circles ſhow the Size of each Bolt, or any Bolt whatever; the two outer Circles ſhow the Size and Exceſs of a two Inch Bolt and the two middle Circles ſhew the Size and Exceſs in an Inch Bolt and $\frac{1}{4}$ of an Inch; the two inner Circles ſhow the Size and Exceſs in a Bolt of half an Inch Diameter. The Line *a. b.* is a Chord Line, to ſhow the Diameter of each ſized Bolt, and the Line *d. b.* ſhows the Exceſs of the Diameter in each Bolt; for the Diſtance between the Line *a. b.* and *d. b.* at every ſized Bolt is the Exceſs in the Diameter, as *d. a.* is the Exceſs at that Size, and ſo on. The Line *b. c.* ſhews the Exceſs in the Circumference of each Bolt; for *a. c.* is the Exceſs in the Circumference of a Bolt of 2 Inches Diameter; that is, the Bolt muſt be ſo much bigger in the Girt than the Augre that bores the Hole, to make good firm tight Work, and alſo *e. f,* is the



the Exceſs or Difference of the Girt in an Inch and $\frac{1}{2}$ Bolt, between the Bolt and the Augre; and ſo diminiſhing toward the Center *b.* where the Exceſs is nothing, and ſuch Figures will ſuffice nicely to ſize the Auger to the Bolt, and alſo to the Trenel. However, I ſhall proceed to make the Fractions more Intelligible, and alſo ſhew the Method I took in calculating the preceding Tables.

The Size of the Bolt-Augre more plainly ſet down in the Fractional Parts, the Inch being divided into 32 Parts.

Inch.			*Inch.*			
0	$\frac{1}{2}$		0	$\frac{1}{2}$	and	$\frac{1}{32}$ and $\frac{56}{100}$ of the $\frac{1}{32}$ Part of an Inch.
0	$\frac{1}{8}$		0	$\frac{11}{16}$	and	$\frac{1}{40}$
0	$\frac{3}{4}$		0	$\frac{13}{16}$	and	$\frac{2}{10}$
0	$\frac{7}{8}$		0	$\frac{15}{16}$	and	$\frac{3}{8}$
1	0		1	$\frac{1}{16}$	and	$\frac{6}{10}$
1	$\frac{1}{8}$		1	$\frac{3}{16}$	and	$\frac{22}{100}$
1	$\frac{1}{4}$		1	$\frac{6}{10}$	and	$\frac{4}{5}$
1	$\frac{3}{4}$		1	$\frac{1}{2}$	and	$\frac{45}{100}$
1	$\frac{1}{2}$		1	$\frac{10}{16}$	and	$\frac{25}{100}$
1	$\frac{5}{8}$		1	$\frac{3}{4}$	and	$\frac{22}{100}$
1	$\frac{3}{4}$		1	$\frac{14}{16}$	and	$\frac{35}{100}$
1	$\frac{7}{8}$		2	$\frac{1}{16}$	and	$\frac{7}{100}$
2	0	The Size of the Augre in Inches and Parts.	2	$\frac{3}{16}$	and	$\frac{35}{100}$

Of the $\frac{1}{16}$ Part of an Inch, the Size of the Bolt ſuitable to the Size of the Augre in Inches and Parts.

The Method to ſize the Bolt to the Augre is as follows,

Firſt, for a half Inch Augre, the Parts are 16 for the Diameter, the Circumference is 50, Cube-Root of which is 3 $\frac{13}{20}$.

The Exceſs is 1 $\frac{70}{100}$, the Cube of which is 4 $\frac{9}{10}$, which I allow for the Circumference of the Exceſs, the Diameter of which is 1 $\frac{56}{100}$, which is the real Exceſs or Difference this Bolt ought to have bigger than the Augre, which is not quite the $\frac{1}{16}$ Part of an Inch.

For an Augre of $\frac{5}{8}$ of an Inch, the Parts are 20, the Circumference of which is 63, Cube-Root of which is 3 $\frac{39}{40}$, the Exceſs is $\frac{84}{100}$, Cube of which is 6 $\frac{1}{10}$ for the Circumference of the Exceſs, Diameter of which is 2 $\frac{1}{20}$, which is the Exceſs or Difference which ought to be between the Augre and the Bolt, in the Diameter of them

For an Angre of $\frac{3}{4}$ of an Inch, the Parts are 24, the Circumference of which is 75, Cube-Root is 4 $\frac{2}{10}$, the Exceſs is 1 $\frac{96}{100}$, Cube of which is 7 $\frac{5}{10}$ for the Circumference of the Exceſs, the Diameter of which is 2 $\frac{4}{10}$, which is the Exceſs or Difference that ought to be between the Augre and the Bolt, in their Diameter.

For an Augre of $\frac{7}{8}$ of an Inch, the Parts are 28, Circumference of which is 88, Cube Root of that is 4 $\frac{4}{10}$, the Exceſs is 2 $\frac{3}{4}$, Cube of which is 8 $\frac{6}{10}$, for the Circumference of the Exceſs, the Diameter of which is 2 $\frac{3}{4}$, Cube of which is 8 $\frac{6}{10}$ for the Circumference of the Exceſs, the Diameter of which is 2 $\frac{3}{4}$, which is the Exceſs or Difference that ought to be between the Augre and the Bolt in the Diameter, which is $\frac{33}{40}$ Parts of $\frac{1}{8}$ of an Inch.

For an Inch Augre the Parts are 32, Circumference of which is 100 $\frac{5}{100}$, Cube-Root of which is 4 $\frac{11}{20}$, the Exceſs is 3 $\frac{2}{10}$, Cube of which is 9 $\frac{2}{10}$ for the Circumference of the Exceſs, the Diameter of which is 3 $\frac{2}{20}$, which is the Exceſs or Difference that ought to be between the Augre and the Bolt in the Diameter.

For an Augre of 1 Inch and $\frac{1}{8}$, the Parts are 36, the Circumference of which is 113, Cube Root of which is 4 $\frac{12}{20}$, the Exceſs is 2 $\frac{1}{10}$, Cube of which is 11 $\frac{1}{20}$ for the Circumference of the Exceſs, the Diameter of which is 3 $\frac{11}{20}$, which is the Exceſs or Difference that ought to be between the Augre and the Bolt in their Diameter.

For an Augre of 1 Inch and $\frac{1}{4}$, the Parts are 40, Circumference of which is 125, Cube Root of which is 5, the Proportional Number for the Exceſs 2 $\frac{1}{10}$, Cube of which is 12 $\frac{8}{10}$ for the Circumference of the Exceſs, the Diameter of which is 4, or $\frac{1}{8}$ of an Inch for the Exceſs between the Bolt and the Augre.

For an Augre of 1 Inch and $\frac{3}{8}$, the Parts are 44, Circumference of which is 138, Cube-Root of which is 5 $\frac{2}{10}$; the Number for the Exceſs is 2 $\frac{4}{10}$, Cube of which is 13 $\frac{2}{0}$ for the Circumference of the Exceſs, the Diameter of which is 4 ^{2}, for the Exceſs between the Bolt and the Augre.

For an Augre of 1 Inch and $\frac{1}{2}$, the Parts are 48, Circumference of which is 150, Cube-Root of which is 5 $\frac{3}{10}$, the Number for the Exceſs is 2 $\frac{9}{20}$, Cube of which is 14 $\frac{8}{10}$ for the Circumference of the Exceſs, the Diameter of which is 4 $\frac{7}{10}$, for the Exceſs between the Bolt and the Augre.

For an Augre of 1 Inch and $\frac{5}{8}$, the Parts are 52, Circumference of which is 163, Cube-Root of which is 5 $\frac{5}{10}$, the Number for the Exceſs is 2 $\frac{11}{20}$, Cube of which is 16 $\frac{2}{10}$ for the Circumference of the Exceſs, the Diameter of which is 5 $\frac{4}{20}$, for the Exceſs between the Bolt and the Augre.

For an Augre of 1 Inch and $\frac{3}{4}$, the Parts are 56, Circumference of which is 176. Cube-Root of which is 5 $\frac{6}{10}$, the Number for the Exceſs is 2 $\frac{6}{10}$, Cube of which is 17 $\frac{6}{10}$ for the Circumference of the Exceſs, the Diameter of which is 5 $_{10}$ for the Exceſs between the Bolt and the Augre.

For an Augre of 1 Inch and $\frac{7}{8}$, the Parts are 60, Circumference of which is 189, Cube-Root of which is 5 $\frac{14}{20}$, the Number for the Exceſs is 2 $\frac{13}{20}$, Cube Number of which is 18 $\frac{8}{10}$ for the Circumference of the Exceſs, the Diameter of which is 6, for the Exceſs between the Bolt and the Augre.

For an Augre of 2 Inches, the Parts are 64. Circumference of which is 200, Cube-Root of which is 5 $\frac{8}{10}$, the Proportional Number for the Exceſs is 2 $\frac{7}{10}$, Cube Number of which is 19 $\frac{7}{10}$ for the Circumference of the Exceſs, the Diameter of which is 6 $\frac{7}{20}$, for the Exceſs between the Bolt and the Augre, which is near a quarter of an Inch.

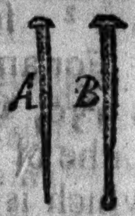
In the next Place I proceed to make ſome uſeful Obſervations concerning Nails, which is a Material of great Importance in Ship building, and ought to be well conſidered. The Word, as I find it in the Expoſitors, is *Clavus*, a Nail or Wedge, and of ſuch Materials there are diverſe Sorts, and great Variety according to the Uſe; but all tending towards faſtening one Part or Material to another, as Wood to Wood, Iron to Wood, Lead to Wood, Braſs or Copper to Wood, Leather to Wood, and the like.

Experience has inform'd us, that Mineral Productions, or Metals, are Offenſive, and will Corrode, Eat, or conſume one another; it being a general Cuſtom in preceding Ages to cover Ships, or what Shipwrights term Sheathing a Ship with Lead, and Nailing of it with Copper-Nails; but then it was obſerv'd, that all the Iron-work under the Lead was miſerably eat and conſumed: Notwithſtanding I am apt to believe that it was not altogether the Lead that was the Cauſe, but the long Continuance of the Iron-work under the Lead, as not being able to ſhift the Iron-work without uncovering the Ship, and ripping of the Lead, ſince I have obſerved the Bolts in the Scarphs of the Keel to be conſumed to as great a Degree as they could poſſibly be under Lead, and never any Lead near ſuch Scarph-bolts; ſo that in all Likelyhood it is the Salt Water that waſtes the Iron, and not altogether the Lead Sheathing.

I ſhall firſt conſider of ſuch Nails as are uſed to faſten Wood to Wood, as Plank on the Ship's Deck, and in ſome Countries all the Plank on a Ship, all Bulk-heads and Partitioning or Flooring, all Projecting Parts of a Ship, as

Rails, Ranges, Kivels, Planſheers, Gunnels, and indeed ſeveral other Parts, too tedious to enumerate and bring into Particulars.

The Shape of Nails are Two-fold, *viz.* Sharp pointed, and Flat pointed; the Sharp pointed is much eaſier drawn back again than the Flat pointed, for which Reaſon all Nails in Ship-work are Flat pointed, except the Ribbond Nails, believing that they will hold much better in the moving and tumbling of a Ship; and alſo the Flat Points will cut ſuch hard Wood (that a Ship is generally compoſed with) much better than if the Points were ſharp and peaked; ſo that the conveniency is Two-fold in Flat pointed Nails; firſt, that the Work will be made much firmer, and by conſequence the Ship the ſtronger; alſo the Point will be better able to make its Paſſage, and be drove much truer into hard Wood; A. being the Figure of a Nail which is term'd Sharp pointed, and B. the Shape of a Nail that is term'd Flat pointed, and the Diſtinguiſhment that is made of Nails is by Names, as well as of all other Materials.



The firſt Degree or biggeſt Size of Nails is called Spikes, which is no other in the ſtricteſt Senſe than a Nail or Nails; from which it may be reaſonably allowed, that a Spike is the Original or firſt Kindred of Nails, if it may be ſo term'd, and that all other ſorts gradually deſcending from them, has ſome other Diſtinction. There are alſo diverſe Sorts of Spikes, as well as Sizes, according to the Uſes requiſite; the ſmalleſt Sort are called Weight Nails, from their being Sold by Weight; the next Size is Forty-penny Nails, and ſo deſcending gradually to Two-penny Nails, as you may ſee in the following Tables; where Note, that Forty-Pence, or 3 *s.* 4 *d.* will Correſpond to the Price of 100 of ſuch Nails, and ſo of the reſt, not but that ſuch Nails may alſo be Sold by the Pound or Hundred Weight, and are often Sold ſo, but Forty-penny, Thirty penny, and the like, gives them a Name that diſtinguiſhes them one from another, which without would be very intricate in bargaining or asking for the Sorts, they being ſo very many.

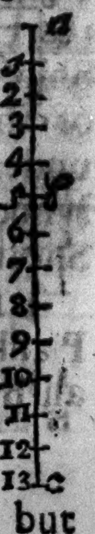
The ſeveral Lengths and Weights being ſet down, as you may obſerve in the Columns adapted for that purpoſe, I ſhall therefore deſcribe the ſuitable Lengths and Bigneſs of Nails, and bring their Dimenſions under General Heads, from the Thickneſs of the Plank, or other Materials that are to be faſten'd.

The Centre of Gravity in Nails, or the Weight of the Head and Point in moſt Nails, is as 8 to 5; that is, the Head and part of the Shank to the Centre is 5 Parts, and from the Point to the Centre is 8 Parts; which I ſhall endeavour to explain, that it may ſuffice to make a general Proportion for all Sorts and Sizes of Nails whatſoever.

But whether this Centre may be generally allowed to divide the Length into equal Parts for all Sorts of Species that are to be faſten'd, I ſhall not at preſent be abſolute; but am really of Opinion it may be a very good guide to young Practitioners, to ſort his Nails to his Work, and not (as it's very often obſerv'd) to drive long Nails where ſhort ones may ſuffice, and ſo ſplit and tear all the Work in the Wake of ſuch faſtening, or otherwiſe uſe ſhorter Nails than what is requiſite; and by ſuch means the Work is never well faſtened, but cauſes a general Complaint in the Weakneſs of the Ship.

In the Figure A. you may obſerve, that the Line *a. b. c.* is divided into 13 Parts, 5 of them being from *a.* to *b.* and 8 of them from *b.* to *c.* That I allow *b.* to be the Centre of Gravity, *a.* the Head of the Nail, and *c.* the Point, and that the Nail from *b.* to *a.* ſhall be of equal Weight to the Nail from *b.* to *c.* I would alſo have every Nail as big at *b.* as at the Head, becauſe there is the greateſt Strain, and from *b.* to Taper gradually downwards to the Point at *c.*

A.



But however, it's not to be underſtood that ſuch a Proportion can be made general, without conſidering the Nature of the Wood that you joyn and faſten, ſince Fir will not require ſuch faſtening as Oak, but the Nail may be as much ſhorter as the Cube Root of 56, the Weight of one Ft of Oak, which is 3 $\frac{37}{40}$, is to the Cube Root of 40, the Weight of one Ft. of Fir, which is 3 $\frac{17}{40}$; and this Difference is to be underſtood of Nails that are uſed in Stuff of 12 Inches thick; for in that which is thinner, Say, as the Difference between Fir and Oak in 1 Ft. thick, which is 1 Inch $\frac{2}{10}$ is to the Difference cauſed in 4 Inch or 3 Inch Plank, or the like; ſo is 12 to 4; but this being backward, you may ſay as 12 Inches is to 4. 3. 2. or whatever the Thickneſs is, ſo is 1 Inch $\frac{2}{10}$ the Difference cauſed in a Foot, to the Difference in 4. 3. or 2 Inches, which is as follows.

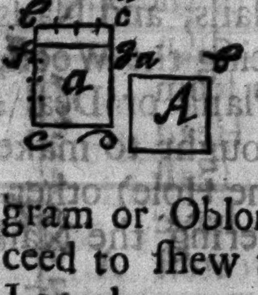
	Inches.	*Inch.*
	12	1 $\frac{2}{10}$
The Difference in the ſeveral Thickneſs.	6	0 $\frac{7}{10}$
	4	0 $\frac{47}{100}$
	3	0 $\frac{35}{100}$
	$2\frac{1}{2}$	0 $\frac{29}{100}$
	2	0 $\frac{23}{100}$

From which it appears, that in a four Inch Plank, the Length from the Head to the Center *b.* ſhall be $\frac{7}{10}$ of an Inch leſs than it ought to be in Oak, and in a 2 Inch Plank or Deal $\frac{23}{100}$ Parts of an Inch, or near $\frac{1}{4}$ leſs in Fir than in Oak, and ſo of the reſt, may be had the Difference in any other Size; but what I have mention'd being generally uſeful in Decks, and the other Work that is Nail'd, I refer the Fractional Parts to the Judgment of the Practitioner, and proceed to ſhew the Bigneſs of the Nails ſuitable to the Lengths.

I am apt to believe, and indeed it ſeems very reaſonable, that if the Strain of Nails was truely Circular, or that every Part of a Nail was equally effected in the Strain, then it would be moſt proper to have all Nails wrought truely and directly Square; but that is not in Shipwork, ſince the Strain is much greater Thwart-ſhips than Fore and Aft, according to the Difference in the moving of the Ship, ſo that inſtead of making Nails directly Square, they ought to be made Parallelopipedon Faſhion; but then the Artificer ought to be ſure to put the biggeſt Part Thwart-ſhips, otherwiſe it would be much better to have them directly Square; but to know how much this Difference is or ſhould be, is in the next Place to be conſider'd, and then to the Bigneſs ſuitable to the Length.

Now the common Difference in Shippings Length to Breadth at or near the Seat of Bearing, is as 4 to 1, and ſo may the moving of a Ship be expected to be, and from thence the Strain of a Nail may be thought propereſt to be allowed; but however, ſuch a Difference I take to be in a greater extream than to make the Nail truely Square, and therefore I ſhall rather conſider it for the Conveniency of Forging the Material ſuitable to the Uſe.

The making of Nails with Broad Points is (as I ſaid before) chiefly conſider'd for Driving, Forceing, or Piercing into hard Wood, as Oak, or the like, believing ſuch Broad Points cuts and clears the Paſſage, which otherwiſe in Sharp Points would hinder the Drift of the Nail, and conſequently be oppoſed, and either Ruck (as it's term'd) bending, or breaking off quite, and never do any manner of Service at all.

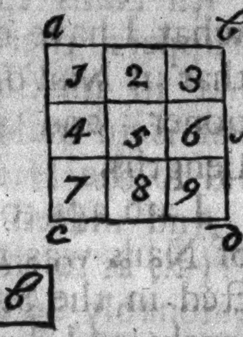


From which advantagious Faculty its farther allowed to have the Body of any ſuch ſhaped Nail agreeable to the Point, which is to fill up again upwards what is cut by the Point, as in the Figure *a.* the Body of the Nail at the Center ſhall be as 5 to 4; that the Difference of all Nails ſhall be $\frac{1}{5}$, if they have Broad Points, as may be ſeen in the Parallelogram *b. c. d. e. f. g, c. d.* being a Quadrat, and *b. c. d. e.* a Parallelogram or Oblong Square, in Proportion as 5 to 4; from which I ſhall proceed to ſhew the Bigneſs of any ſuch Nail (at the Center) agreeable to the Length.

The general Proportion of Nails for Ship-work (and the like) is as 18 to 1; that as the Bigneſs of the Nail at the Center *b.* as aforeſaid, to the Length, is as 1 to 18; which is thus to be underſtood, that the Side *a. b.* in the Figure *A.* is to the Length of any Nail of ſuch a Bigneſs, as 1 is to 18, or the $\frac{1}{18}$ Part.

Now in making Broad Nails, or ſuch as are bigger one way than they are the other way, you are to obſerve that it's not adding the two Sides of an Oblong Figure together, and then to take one half of the Sum will give the true Side of a Square agreeable to ſuch an Oblong; for in caſe an Oblong was compoſed of 2 by 8, if you add the Sums together it will be 10, the half of which is 5; but if you multiply 8 by 2, it's 16, the Square Root of which is 4, for the true Side of the Square made up of 8 and 2, and ſo ought the Bigneſs of all Oblong faſhion'd Nails be conſidered; but to a general Proportion of the Bigneſs I ſhall conſider of it from the Nature of Solids.

The Strength of Solids being according to the Square of the doubling, or augmenting the Rod in Subſtance, ſo that if one Nail be 14 Inches long, and $\frac{3}{4}$ of an Inch Square at the Center, and another Nail be 4 Inches and a half long, and $\frac{1}{4}$ of an Inch Square, the Length is near as 3 to 1, but the Subſtance is as 9 to 1; ſince there are 9 Quarters in $\frac{3}{4}$ of an Inch Square, as in the Figure A. you may obſerve that every Part being $\frac{1}{4}$, as from *a* to *b* is 3 Quarters, and the other way is alſo 3 Quarters, which multiply'd one into the other is 9 Quarters; ſo that *a.* contains 9 of *b.* Now was a Rod equal in Subſtance to *b.* compared with another equal in Subſtance to A. and to be both of equal Length, then A. would be 9 times as ſtrong as *b.* according to the Square of ſuch doubling, or 3 × by 3, which is 9: But ſince the Nail A. is 3 times as long as the Nail *b.* it can be expected to be but $\frac{1}{3}$ of that Strengh, which is as 1 to 3, or A. 3 times as ſtrong as *b.* from which it will follow, that a Rod of $\frac{3}{4}$ of an Inch Square will be as ſtrong as a Rod of $\frac{1}{4}$ of an Inch Square, provided the large Rod be 9 Foot long, and the ſmall Rod 1 Foot long; and therefore it will be inconſiſtent with Reaſon to have all Nails equally ſtrong, ſince they will not bear the Percuſſion or Stroke which will be requiſite to force them with ſuch extream Lengths, ſince the Reſiſtance will be according to the Area made by the Shank of the Nail at a Croſs Section near the Center of the Nail as aforeſaid.



And ſuch Conſiderations may ſuffice to ſize the Nails for faſtening Plank in Ship-work or Boards, or the like; I ſhall therefore mention ſome other particular Cautions which ought to be minded in the Inſpection, and providing other Nails, and alſo what ought to be nicely complied with in Forging ſuch Materials.

In Forging Nails great Care ought to be taken in tempering the Iron, not to let it be too hard or too ſoft, but rather from a Medium to have a degree of Softneſs or Ductile than too hard and brittle.

Not to burn the Iron, or ſtrike before it be hot, from making it Porous or Flawy; to make ſuch Materials very ſmooth and even, and more particularly to obſerve that the Heads of Nails be well placed on the Shank, and to be made very ſubſtantial, tho' ſuch Parts are perform'd diverſe ways, according to the Uſe requiſite in ſuch Materials, as in Sheathing Nails, and Nails for Decks, the Heads are made Hook-wiſe downwards, for Piercing the Wood, and being ſoked even or within the Wood, or flat of the Plank or Deal; where Note, if ſuch Nails are made ſmooth downwards, you ought to make way for the Head with the Gimlet or Piecer (term'd Gulling the Hole) otherwiſe it's very rare but that the Head is forced off in Hammering the Nail into the Wood.

In Sheathing there ought to be a particular Care in ſizing the Nail, as I ſhall fully inſtance when I mention the Sheathing Board, and what Care and Caution ought to be obſerved in Sheathing Ships.

All Nails that are drove into Iron, as in Rudder Irons, Port Hinges, or the like, where the Iron Strap or Hinge is not above half an Inch thick, or thereabouts, there the Nail's Head and the Part that contains the Thickneſs of the Hinge, ought to be as heavy as all the other Part of the Nail, and be made very firm, broad and ſubſtantial, and the Holes in the Straps ought to be made very fit for the Bigneſs of the Nail; ſo that it will be highly neceſſary in ſuch caſes to make the Holes and the Nails together, or to make them by an exact Gauge, ſince it would be a great Preſervation to the Head to have the Nail and the Hole fit nice, or rather ſomething of the ſtiffeſt; alſo to lay Oakham or ſome ſuch ſoft Matter between the Head, as well to fill up the Vacancies between the Head and the Strap, as to moderate the Meeting of the hard Metal.

The Heads of ſuch Nails as faſten Lead, ought to be as heavy as the other Part; and here may be made very nice Tryals, whether Lead eats Iron, in the Nails that's drove into Lead, and whether it is not the Salt Water that is the greateſt Waſter in ſuch a Mineral Production.

All Nails that are drove into or faſten Leather, as particularly Leather Scuppers, there Heads ought to be as heavy as all the other Part, obſerving that in making ſuch Materials there are great Faults committed, and that is in making the Heads ſo extream thin, that they frequently break off, and ſo the Head becomes uſeleſs.

And indeed in ſuch Nails as faſten Lead or Leather, there requires nice Tryals as to there Lengths, ſince the Thickneſs of the Lead or Leather cannot reaſonably be allowed to guide the Length; but as to Practice I will allow the Diameter of the Head to be 4 times the Thickneſs of the Lead, or any ſuch Matter as the Nail is propoſed to faſten; and for the Weight of the Head, it ſhall be equal to a Piece of the Lead of the ſame Bigneſs with the Head, and according to the Lead's various Thickneſs; and in Leather the Head of the Nail to be equal in Weight (to a Superficies and a half of the Head) and of the Leather that the Nails are drove into, the Bodies of ſuch Nails equal to the Weight of the Head, and for the Bigneſs under the Head let it be $\frac{1}{9}$ of the Length of the Nail, and ſo for the Nails that are adapted to faſten Lead; Alſo, that in the Heads of all Nails that are uſed to faſten Iron, the Head ſhall be 4 times the Thickneſs of the Iron Strap; for the Diameter of the ſame; and for Weight, let that be equal to a Piece of the Iron it faſtens, and of the ſame Bigneſs with it's reſpective Head.

And indeed Nails which are drove into Iron cannot be too ſubſtantially headed, ſince on the good or ill Diſpoſition of that Part depends that Value which may be ſet on ſuch Materials; not but that the Shank of all Nails ought to be truly Tapered to the Point, and the Point to be ſhaped truly Circular as to the cutting way.

Woolding Nails are made round, that they may not cut the Yarn they are drove into, the Points being made Sharp, and the Heads Flat, all for the ſafety of the Rope they faſten, notwithſtanding there is old Leather put between the Head of the Nail and the Rope.

The Nails which faſten Keel-bands, and the like, are called Brads, having no Material Head, only are made bigger at the Place of the Head, that they may juſt ſtop and be covered, which ought to be nicely perform'd, and made exactly fit in their reſpective Holes.

There be other Sorts of Brads that Joyners uſe, which are made on purpoſe for the Curioſity of the Sight, that the Heads may be wholly ſunk within the Wood, with ſmall Materials, as Four-penny, Three-penny, and Two-penny Nails, and Brads of every Sort for the Joyners, alſo Tacks, and the like, cannot be too dexterouſly perform'd, both for the good of the Work and diſpatch of the Artificer.

The following Table is a general Proportion for the Length and Bigneſs of Nails, according to the Size of the Plank they are uſed in.

Thickneſs of the Plank or thick Stuff in Inches and Parts. Inches.	Length of the Nail ſizeable to faſten a Plank of that Thickneſs. Feet.	Inch.		Bigneſs of the Nail at the Center of Gravity as aforeſaid in Inches and 100 Parts of an Inch. Inches.	
12	2	7		1	74/100
11	2	4	1/2	1	6/10
10	2	2		1	46/100
9	1	11	1/2	1	20/100
8	1	8	1/4	1	16/100
7	1	6	2/10	1	1/100
6	1	3	6/10	0	87/100
5	1	1		0	72/100
4	0	10	4/10	0	58/100
3	0	7	8/10	0	43/100
2 1/2	0	6	1/2	0	26/100
2	0	5	4/10	0	30/100
1 1/2	0	3	9/10	0	22/100
1	0	2	6/10	0	14/100
0 3/4	0	1	95/100	0	11/100
0 1/2 Board	0	1	30/100	0	72/1000
0 1/4	0	0	65/100	0	36/100

Memorandums on the Tryal of Nails.

A Nail 14 Inches long, the Center was 5 and a qr. and 8 and a qr. Bigneſs, 3 qrs. of an Inch the flat of the Point the ſame Bigneſs broad-wiſe.

A Nail 4 Inches and half, the Center from the Head 1 and a half, and from the Point 2 and 3 qrs. Bigneſs at the Center 1 qr. of an Inch, the Point equal to that.

A Nail 3 Inches and a half, the Center from the Head 1 and 3/8, and from the Point 2 and a qr. Bigneſs 3/16, and the Point equal.

All which holds with my Obſervations of Trenels, which is in Over-hauling, or making leſs the Middle, and keeping the Subſtance at the Point.

And now for a general Proportion for ſuch Nails as are drove into Rudder-Irons, Port-Hinges, Lead, Leather and the like.

Thickneſs of the Iron Straps in Inches and Parts. Inches.		Length of the Nail. Inches.	Bigneſs of the Nail in Inches and Parts. Inches.	
1	0	8	1	0
0	7/8	7	0	7/8
0	3/4	6	0	3/4
0	5/8	5	0	5/8
0	1/2	4	0	1/2
0	3/8	3	0	3/8
0	1/4	2	0	1/4
0	1/8	1	0	1/8

The Breadth of an Iron Plate to its reſpective Thickneſs, may be as 7 to 1; ſo that if an Iron Plate be 7 Inches broad, it ought to be 1 Inch thick, and ſo on to a general Proportion that way.

And by ſuch Calculations may all Nails that faſten Lead, Copper, Braſs, or Leather be ſized.

Before I ſay any Thing concerning the Price of Anchors, which ſhall cloſe this Obſervation concerning the Smith's Buſineſs, I will ſet down the Dimenſions and Prices of the Smith's Materials, according to the Cuſtom and Nature of contracting in the Publick Service; but will not mention the Preamble that is uſual in ſuch Agreements, but rather refer that Part to be made out by any common Scrivener, when it ſhall be required; neither will I be ſo tedious as to mention every Sum, and alſo the Dimenſion of the Material in Words at length, but will make ſuitable Columns for that Purpoſe, being deſirous to fill a Volume with real Matter, and not Tautology. Only to make the Contracts entire, I ſhall repeat ſome particular Heads that I have explain'd in another Place, and ſhall alſo make ſome uſeful Obſervations on the Materials which require it, as I proceed.

Species.	Value. l.	s.	d.	
For all wrought Work in general from the Forge rough	1	12	0	per C. wt.
For new wrought Work	0	13	0	

For Praiſed-Work.

	l.	s.	d.	
For Boats Awning-Irons, Sounding-Irons, Keel bands, Stays for Lanterns, Window-Bars under $\frac{3}{4}$ of an Inch Diameter, and Rudder-Staples for Ships	0	0	3	per Foot.
Boat-Hooks	0	0	9	each.
For the new ſetting a Chain-plate, or making a new Neck to it, Dead-eyes bound to an old Collar, Cringles for Gibb-ſtays, Hoops for reeming Beatles	0	0	8	each.
For righting or pointing a Crow, Clench-Hammers mended at any End, Fids ſharpen'd, Pick-axes mended at any End, Wedges mended at the ſmall End, Marlin-ſhikes mended, Cuts, Shuts and Rights, Caſement-hooks, ſmall Staples	0	0	1	each.
For ſhuting a Crow, mending Fids at the great End, Curtain Rods per Foot, ſquare Staples for Ports, Wedges mended at the great End, Hooks for Rope-makers	0	0	2	each.
Plates for the Tops, ſmall Tackle-hooks above 3 qrs. of a Pound, Handles for Two-hand Saws, Caſement-Locks, Stays for Caſements with 2 Eyes, Port-Rings and Eyes of all ſorts, Hatch-Rings and Eyes, Staples lor Pump-Boxes	0	0	4	each.
Rudder-Thimbles, Pot-Hooks, Firrels for Saws, Hooks for Rope-makers to lay with	0	1	0	each.
Staples for falſe Keels, Spindles for Vanes per Foot, Knees for Boats per Foot, Hoops for Poop-Lanterns per Foot, large Thimbles, new Claws to Crows, Hatchet-Tacks or Teeth 9 Inches and a half long and half an Inch broad	0	0	5	each.
Spinning Whirls for Rope-makers, Stays for Doors with two Eyes	0	0	6	each.
Pump Brakes fixed	0	0	10	each.
New Firrels for Saws, middling Staples,	0	0	$1\frac{1}{2}$	each.
A Tiller for a Whip-ſaw, Rudder-Irons for Long-Boats by the Pair	0	1	4	each.
Rudder-Irons for Pinnaces, Pins and Chains for Capſterns, Prongs with Firrels	0	1	2	each.
Brads for Keel-bands	0	1	0	per C. wt.
For opening and ſhutting the Neck of a Chain-plate, and mending double Headed Mauls at one End, for large round Staples, Haſps, round Bolts for Doors, ordinary Thimbles	0	0	3	each.
For Caſements either ſquare or raking, $\frac{1}{4}$ of an Inch thick, meaſuring only one Side and one End	0	1	6	per Foot.
Pick-axes well ſteel'd	0	0	$3\frac{1}{2}$	per Pound
Oven-Lids	0	0	4	per Pound
Suits for Spaniſh Wainſcot Tables	0	5	0	each.
Suits for Wheel-barrows	0	2	0	each.
Andirons	1	10	0	per C. wt.
Augre-Bits one with another, from half an Inch Diameter to 2 Inches Diameter	0	2	0	each.

Iron Work from the Iron-mongers.

Species.	Value. s.	d.		Dimenſion. Leng. Inch.	Bread. Inch.	Obſervations.
Axes well ſteel'd	2	4	each.	11	3	May be provided as any Ship is building.
Plate Bolts with a Staple to each	4	8	per	4	$1\frac{1}{2}$	
Spring Bolts with a Staple to each	6	4	Doz.	$4\frac{1}{2}$	$1\frac{3}{4}$	
Cold Chiſſels	1	0	each.	7		
Dutch Rings poliſh'd extraordinary	6	0	Doz.			May be provided as any Ship is building.
Ordinary flower'd Scutcheons	2	0	Doz.			
Fire Forks	1	7	each.	30		For the Uſe of the Sea Service.
Fire Shovels				28		
Fire Tongs				24		
Fleſh-Fork	0	$9\frac{1}{2}$	each.	18		For the Ship's Cooks.
Furnaces	0	4	per *l.*			
Hammers Clench	1	1	each.	$4\frac{1}{2}$	$1\frac{1}{2}$	For Riveting Bolts.
Hack	1	1	each.	$7\frac{3}{4}$	$1\frac{3}{4}$	For hacking a Saw to cut off Bolts.
Hatchets well ſteel'd	14	0	Doz	7	$4\frac{1}{2}$	
Handles for Doors	10	0	Doz.	$7\frac{1}{2}$ & 8	$1\frac{3}{4}$ & 2	
All ſorts of Hinges.						
Caſements	0	5		$5\frac{3}{4}$	2	This and all other ſmooth Work that is bright ought not to be provided before it be ready to be uſed.
Extra ſmooth	10	0				
Dovetails ordinary	4	0	Doz.	4	3	
Dovetails extra	6	0	Pair.	5	$3\frac{1}{2}$	
Eſs Hinges Large	14	0		9	$3\frac{1}{2}$	
Eſs Hinges Middling	9	0		7	3	
Croſs Garnets between 14 and 16*l.*	0	$4\frac{1}{2}$	per *l.*	26		
Latches long ſmooth fil'd	9	0	Doz.	10 11		
Dozen Garnets Extra.	16	0		17	6	
Dozen Garnets Ordinary	12	0		12	$4\frac{1}{2}$	Such Materials ought to be us'd as they are brought from the Ironmongers, otherwiſe they will grow ruſty, and worſe than if they were rough Work.
Lambheads	4	6		$4\frac{1}{2}$	$2\frac{1}{2}$	
Scuttle Hinges Extra.	16	0	per	$16\frac{1}{2}$	3	
Scuttle Hinges Ordinary	12	0	Doz.	12	$2\frac{1}{2}$	
Side Hinges Extra.	13	0	Pair.	9	$2\frac{7}{8}$	
Side Hinges Ordinary	13	0		$7\frac{1}{2}$	$2\frac{3}{4}$	
Butt or Tables	5	4		$3\frac{1}{2}$	2	
Tumblers	7	6		$4\frac{1}{2}$	2	
Riſing Joynts	1	6	one			
Extra. ſmooth fil'd	4	0	Pair.			
Latches.						
Long Ketches	1	6	Doz.	$10\frac{1}{2}$		All Locks, eſpecially bright Work, ought to be well oyled and kept clean; their Duration would be near twice as long, as when neglected; for which reaſon it would not be at all improper to have them taken off and clean'd, repair'd and well oyl'd every 3 Months.
Spring Ketches	13	0	Doz.	$7\frac{3}{4}$	$2\frac{1}{2}$	
Locks.						
Cheſt and Settle Lockers	1	7		$5\frac{1}{2}$	$3\frac{1}{2}$	
Hanging	1	1		$3\frac{1}{2}$	3	
Double Spring	2	4		$8\frac{1}{2}$	$5\frac{1}{2}$	
Single Spring	1	1	each	$6\frac{1}{2}$	3	
Stock Extra.	2	4		12	$6\frac{1}{4}$	
Stock Ordinary	1	5		10	$5\frac{1}{2}$	
Cubboard	1	7		$3\frac{3}{4}$	3	
Caſements	0	$4\frac{1}{2}$				

Iron

Iron Work from the Ironmongers.

Nails of Sorts.	Species.	Weight of 1000 of each.		Value.			Quantity.	Len in Inc.
Brads	24	48		0	1	2½		4
	20	30						3½
	0	20						3
	6 Penny	12						2½
	4	4	Pounds	0	0	6		2
	3	2¾						1½
	2	1½		0	0	9½		1
Deck	Clamp	200						6
		150						5
		135	Pounds	1	13	0	per *C.* wt.	4½
		120						4
		360						8
		280						7
	Double	250						6½
		220	Pounds	0	0	4½	per *l.* wt.	6
		130						5½
		120						6
		100						5
		86						4
		75						4
	Single	60						5½
Filling	10							
	6							
	4 Penny			0	0	4½	per *l.* wt.	
	3							
	2							
Lead	6	12		0	0	5		1¼
	4 Penny	5½	Pounds	0	0	5¾		
	3	3¾		0	0	5¾		
Scupper	4 Penny			0	0	6		
	3		as demanded					
Plate	24			0	0		per Pound	4
	20 Penny			0	0	4½		3
	6			0	0			2
	4			0	0	5		1½
Port	Double	146						5
	Middling	100						5
	Large	120	Pounds	0	0	4½		4
	Single	74						3
	Large	60						3
	Small	45						2½
Pump								2
		2		0	0	7	Pound.	4
								3
				0	0	3		2
Rivets								1½
				0	0	2	per Doz.	5

Obſervations.

Such ſort of Materials ought to be very nicely perform'd, they being for faſtening Keel-bands and Iron Plates and for Joyners Work.

Clamps are Iron Conveniencies for hanging up a Stage or Scaffold, or for Receiving the End of a Staff to ſet or bend a Plank about a round Place or the like for which reaſon the Nails ought to have large and ſubſtantial Heads, and well made.

Deck Nails are for faſtening all Decks, and the Heads are forked downwards.

Filling Nails are ſuch as are drove into Sheathing, to fill up the Vacancies between the Sheathing Nails in ſuch Ships as go to the *Eaſt Indies*, and are not ſo long as the Nails that faſten the Boards to the Ship.

Lead Nails are not properly meant to be made of Lead, but for faſtening of Lead.

Scupper Nails are ſuch as faſten the Leather Hoſes that drains the Water from the Decks.

Plate Nails are ſuch as faſten Iron Plates.

Port Nails are ſuch as faſten Port Hinges, and ought to have ſubſtantial Heads.

Pump Nails are ſuch as are uſed to nail the Leathers on the Churn Pump Boxes, and ought to be very ſound.

Rivets are in common uſe in all ſorts of Buildings, but little made uſe of in Ship-work.

Iron

Iron-work from the Iron-mongers.

Nails of Sorts.	Species.	Weight of 1000 of each.	Value.	Quantity.	Len in Inc.	Obſervations.
			0 0 3		4	
	with filed	Heads.		per	1	
Rivets		filed.	0 0 5	Dozen.	2	
					1½	
	60	224			8	Rough and Clench are made uſe of for Boats that are call'd Clench-work, one Board lapping over another, as in particular, Wherry-work, for which reaſon they are built with thin Board, and row ſwift, from their being extream light.
	40	100			6	
	30	70	0 0 4½		4½	
Rough	24	50			3¾	
and	20 Penny	36 Pound	0 0 5	per	3	
Clench	16	26		Pound.	2½	
	10	16	0 0 5½		2	
	5	9			2	
	4	7			1⅞	
					1⅜	
Riſing	Wherry			per		
Timber	with Rough		0 2 4	Hund.	3	
	with Rough				2½	
	Scupper	5½ 3¾	0 0 5¾	per Pound.		
					6	
				per	5½	Rudder Nails are ſuch as nail the Rudder Irons, and ought to be made very ſubſtantial.
	Rudder		1 13 0	C. wt.	5	
					4½	
					4	
	40	98			5	
	30	68			4½	
	24	50	0 0 4⅝		3¾	
	20 Penny	35			3¼	
Sharp	10	22 Pound			3	
	6	14			2½	Sharp Nails are ſuch as are ſharp pointed.
	4	5½		per		
	3	3½	0 0 6¾	Pound.		
	2	2½				
	40	90			4	
	30	68			3½	
	24	50 Pound			3¼	Flat Nails are ſuch as are flat pointed.
	20 Penny	40	0 0 4	per Pound.	3	
Flat	12	35 to 32			2¾	
	10	26			2½	
	8	22			2¼	Sheathing Nails are ſuch as are made uſe of to nail the Sheathing Boards to the Ship, and the Heads are forked downwards.
	6	18			2	
	4	15			1¾	
	20 3weighs	2 Ounces			3⅛	
	10 5 ditto	2		per	2⅝	
Sheathing	8 Penny 10	weighs 2¼	0 0 4	Pound.	2¼	
	6 11	weighs 2			1¾	

Iron-work from the Iron-mongers.

Nails of Sorts.	Weight of 1000 of each.	Value. l.	s.	d.	Quantity.	Len in Inc.	Observations.
Woolding	28 Pound	0	0	5 ¾	perPound	3	Woolding Nails are ſuch as are made uſe of to nail the Ropes on the Ship's Maſts.
Spikes ordinary	32 the Weight in Ounces of each.	1	10	0		16	Spikes are the largeſt ſort of Nails.
	24					14	
	18					12	
	13					10	
	11					9	
Weight. Nails	16 the Weight in Ounces of each.	1	13	0	per C. wt.	14	Weight-Nails may as well be called ſmall Spikes, they being a ſort between Spikes and ſuch Nails as are numbred by Pennies for their better Diſtinguiſhment.
	13					12	
	10					10	
	8					9	
	6 ½					8	
	5 ¼					7	
	4 ¼					6½	
	4					6	
Tacks of Sorts		0	1	0	perThouſand.		Tacks are the ſmalleſt ſort of Nails.

Iron-work from the Iron-mongers.

Species.	l.	s.	d.	Quantity.		Obſervations.
Pots for Pitch	0	0	2 ½	Pound.		
Needles Bolt-rope	0	3	0	per Dozen		
Needles Small ditto	0	2	0			
Needles Sail	0	1	6			
Saws Two Hand	0	4	0	each.	48	
Saws Whip	0	7	6		78	6 Inches broad.
Saws Hack	0	2	6		34	
Scrapers well ſteel'd	0	16	6	Dozen.	7	4 Inches broad.
Screws for Tables, Beds or Locks	0	0	2 ¼	Piece.		Scrapers are to ſcrape off the Dirt from any part of the Ship's Side or Decks.
Spits	0	0	4	Pound.		
Staples and Gromets, that is, 12 Staples, 12 Rings, and 12 Haſps	from 0 to	1 1	6 10	Dozen Pair.		For the Sea Service are Spits.
Staples for Stock Locks	0	0	1	each.		
Staples for Spring Locks	0	2	4	Dozen.	5	2 Inches broad.
Whirls for Rope-makers	0	1	0	each.		

I ſhall mention the Nature and Quality of Locks next.

Species.	Obſervations.	Value. l.	s.	d.
Cheſt and Settle Locks.	In each Dozen to be 3 with Bullet-wards, 3 drill'd up to the Top of the Pipe, 3 with long Wards, and 3 with Croſs Wards half way with Braſs Scutcheons, to be in Lenngth from 4 Inches and a half to 5 Inches and a half, and in Breadth from 2 and a half to 3 Inches and a half each Lock, and to be tied up in a Paper by itſelf ——— ———	0	1	10 each.
Cupboard Locks.	In each Dozen to be 3 with Bullet Wards, drill'd up to the Top of the Pipe, and 3 with long Wards, and 3 with Croſs Wards, half with Braſs Scutcheons from 3 and a half to 4 Inches long, and from 3 Inches to 2 and a half broad ——— ——— ———	0	1	10 each.
Double Spring.	In each Dozen to be 2 drill'd, 2 with Hoops, 4 to lock on both Sides, 2 with Bullet Wards, 2 with Brims from 7 to 8 Inches long, and from 3 and a qr. to 5 Inches broad ——— ———	0	2	6 each.
Hanging-Locks.	In each Dozen to be 4 round Barrels, 2 half Rounds, 2 S. bitted, 2 croſs Warded, and 2 with Bullet Wards——	0	1	2 each.
	Extraordinary Hanging ———	0	3	0 each.
Extraordinary Double Spring Locks.	In each Dozen to be 3 with Bullet Wards, 3 with great Croſs, 2 with croſs Wards, 2 with ſliding Bolts, 2 with Herring Bone, all with Iron Rims, one half to draw back and lock once dead, the other half to lock twice dead, in every Dozen to have Steel Tumblers, Caſe-harden'd Keys, the Ward to run round, and to be from 7 Inches to 8 Inches and a half long, and from 4 to 5 Inches broad ———	0	8	0 each.
Spring Locks.	In each Dozen to be 3 with Hoops, 2 with croſs Wards, 3 with Bullet Wards, 2 to lock on both Sides, 2 drill'd up to the Top of the Pipe ——	0	1	6 each.
Stock Locks.	In each Dozen to be 3 with the Work fix'd on the Iron; the other 9 from 9 Inches to 10 Inches and a half long, and from 5 to 6 Inches broad, the Stock to be made of well-ſeaſon'd Oak ——	0	1	7 each.
Extraordinary Stock Locks.	In each Dozen to be 3 with the Work fix'd upon Iron, 3 with Bullet Ward, 3 with Bottom-plates, and 3 with Croſs Wards, from 11 Inches and a half to 12 Inches and a half long, and from 6 Inches and a qr. to 6 Inches and a half in Breadth, the Stock to be made of well ſeaſon'd Oak ——— ——	0	2	6 each.

And-

Species	Value. l.	s.	d.		Obſervations.
Andirons black.	1	13	0	per *C.* wt.	You may obſerve, that there is 11 *s.* allowed in every Hundred Weight for poliſhing and making Iron bright.
Ditto bright.	0	0	4½	per Pound	
Augre-Bits of Sizes.	0	12	0	per Doz.	You may alſo obſerve, that there is 14 *d.* Difference in every Augre, between Ingineer-work and the common Work.
Ditto of Ingineer-work.	0	2	2	each.	

The Nature and Value of Hand-Screws (by ſome called Jacks) I will inſtance next, although ſuch Materials are indeed Engines, or mixt Machines; and to fully illuſtrate their Nature and Uſe, would take up a large Volume; beſides, I believe it to be more proper to annex that Conſideration to all Engine-work (relating to Ship-building) in general, and in this Place will only ſhew the Value not only of every Part in ſuch Engines, but of the whole Work as follows.

Species.	Value. l.	s.	d.	
Repairing Hand-Screws.				
For a new Stock of Elm	0	4	0	
A new Wheel	0	6	0	
A new Nut of 4	0	3	0	
A new Nut of 3	0	5	0	
A new Bar	0	8	6	
For ſtreightning and ſetting of the Teeth of an old Bar in every reſpect	0	1	6	
For a new Firrel-Plate	0	1	6	
For a new Bottom Stay	0	1	0	
For a new outſide Plate	0	1	0	
For a new Knob rivetted on an outſide Plate	0	0	6	
For a new ſquare Knob	0	0	6	
For a new Claw to a Bar	0	2	0	
For a new Pin	0	0	2½	
For a new Button	0	0	2	
For a new Spir	0	0	2	
For a new Hook	0	0	2	
For a new Staple	0	0	1	
For a new Head to a Bar	0	1	3	
For a new Tooth to a Bar	0	1	0	
For a new Iron Handle	0	1	0	
For a new wooden Handle	0	0	3	
For a new Forlock	0	0	1	
For cleaning each one with another	0	2	0	
The Price of new Hand-Screws,				
For a new Pair of 3 Foot and a half long	2	10	0	each.
For a new Pair of 3 Foot long	2	5	0	
For a new Pair of 2 Foot and a half long	1	10	0	
For a new Pair of 2 Foot long	1	5	0	

I ſhall ſum up the Nature of the Smith's Contract, with making ſome general Obſervations on the Price and Uſefulneſs of Anchors, in the proſecuting of which I ſhall firſt ſet down a Copy of a Contract I found enter'd for one of the Maſter Smiths in the Publick Service, and dated the 3d Day of *December*, 1698.

	Value. *l.*	*s.*	*d.*
For ſtreightening and refitting an Anchor in all its Parts	0	1	6
For cutting of an Anchor in the Shank, and ſhuting on a new Piece of Shank	0	1	6
For weilding or new ſhuting on an old or a new Ring to an Anchor, and taking out the old Ring	0	0	8
For new pointing an Anchor when the Bills are broke off	0	0	9
For weilding a Palm of an Anchor old or new	0	1	6
For cutting off a Palm of an Anchor, and making it a mooring Anchor	0	1	0

For every Hundred Weight any Anchor doth weigh, that is to be repaired accordingly.

And for every Pound of Iron that ſhall be added to an old Anchor, for making good the ſame, he was to be allowed the Price per Hundred as for Anchors of the like Bigneſs, (as you will ſee in the following Tables) over and above the ſaid Rates for repairing Anchors.

The Price for making of new Anchors is as follows:

Hundreds. Size of the Anchors in Hundred Weights.	Price per C. according to their reſpective Weights. *l.*	*s.*	*d.*	The whole Value of Materials and Workmanſhip, or the Charge of the Anchor delivered from the Forge for the biggeſt Size. *l.*	*s.*	*d.*
from 70 to 66	4	2	6	292	15	0
from 65 to 60	3	12	6	235	12	6
from 60 to 55	3	5	6	196	10	0
from 55 to 50	2	17	6	157	2	6
from 50 to 45	2	12	6	135	5	0
from 45 to 40	2	8	6	105	2	6
from 40 to 35	2	6	6	93	0	0
from 35 to 30	2	4	6	77	17	6
from 30 to 20	1	19	6	58	1	0
from 20 to 10	1	17	6	37	1	0
from 10& under	1	14	6	17	5	0

C. wt. The Weight of an Anchor of the ſeveral largeſt Sizes, which is alſo the Weight of Coals requir'd to forge them in 100 wt.	The Quantity of Coals reduc'd into Chaldrons, Buſhels and Gollons' *Chald.*	*Buſh.*	*Gall.*
70	2	8	5
65	2	3	6⅔
60	1	33	6⅓
55	1	28	1⅙
50	1	22	2½
45	1	16	3⅚
40	1	10	5 4/6
35	1	4	6⅓
30	1	1	0⅙
20	0	23	2½
10	0	11	5¼

C. wt. The Weight of an Anchor is the Weight of Coals, and that reduced into Chaldrons, and each Chaldron at 29 *s.*	The Value of the Coals allowed to make an Anchor of the ſeveral Sizes mentioned. *l.*	*s.*	*d.*
70	3	4	10¼
65	3	1	2
60	2	15	9½
55	2	11	6¼
50	2	6	7¾
45	2	2	0½
40	1	17	5
35	1	12	9¼
30	1	9	9¾
20	0	18	6¼
10	0	9	3⅛

In the next Place I am to conſider the Time and Charge of working an Anchor of the ſeveral Sizes: You may obſerve, as I hinted before, that large Iron may be wrought much cheaper than ſmall Iron, as to the Workman's Labour, provided the large Iron is as properly adapted and brought to the Forge as the ſmall Iron is, according to their reſpective Bulks and Magnitude, ſince the Fires will be equally efficacious, and heat the large Iron in as little time as the ſmall Fires will heat the ſmall Iron; for ſince the Superficies to the ſolid Content is as 1 to 2, the Hammer Strokes will be accordingly, and conſequently large Iron well managed may be Forged much cheaper than ſmall; but then there muſt be ſome Reaſon given, otherwiſe why ſhould the different Price be ſo very much between large and ſmall Anchors, and for it perhaps the Smith will alledge, there is a great deal more Waſte in one than there is in the other; which indeed at preſent ſeems a Paradox to me how it can be made out. I know the Cuſtom in Forging Iron, which is much larger than any Bars that are run from the Furnace, is to put as many Bars together as will make up the Scantling of the Part which they deſign to Forge, and they being hoop'd and wedg'd together, are put into the Fire prepared for that purpoſe; and in ſuch a Fire it ought to lye until the Parts be every one thorough hot, and almoſt ready to melt, and then all the ſmall Bars will wield together by the Strokes of the Hammer, or Percuſſion of the Smith; and indeed every Part ought to be as well connex'd to the other as Metal that's run from the Furnace; but whether they are ſo joyn'd or not will be very difficult to define, and if it can be ſo proved that every Bar was connex'd, knit, or joyn'd nicely together, then pray what becomes of the Cruſt, or the great Waſte which is made, and what the Smith pretends is beat off in Forging; and where muſt it creep out, if every Bar is knit together, and the Vacuities ſtopt, and all the Paſſages which ſuch Droſs or Waſte ſhould paſs at be ſhut up; and if they are not releaſed, but ſhut in and confin'd with the good Iron, then where is the great Waſte which calls for ſuch an Allowance.

But perhaps the Smith will be apt to ſay, the out ſide Bars will be great part melted before the inſide Bars be near hot, and by that means the Waſte is made; this indeed may be very probable, but then is that always found, or is it accidental? if it be accidental, it ought to be prevented by Care, otherwiſe where is the nice Dimenſions complied with, or where is the certain Dependance.

I ſhall for tracing this Matter a little farther, ſet down ſome particular Dimenſions of Two Anchors, and calculate their Superficies, and from thence the Number of Men requiſite to Work them.

	Foot.	*Inch.*
Length of the Shank of the biggeſt Anchor is ———	18	6
And of the ſmall Anchor —— —— ——	10	8
Bigneſs in the middle is —— —— ——	00	10
And of the other it is —— —— ——	00	5 $\frac{6}{10}$

The Weight of the biggeſt is 71 Hundred 2 Quarters, and the Weight of the leaſt is 11 Hundred 2 Quarters.

The Price *per* Hundred of the large Anchor is 4 *l.* 2 *s.* 6 *d.* and of the ſmall Anchor 1 *l.* 17 *s.* 6 *d.*

The Total Sum for making the large Anchor, and finding Iron, is 298 *l.* 18 *s.* 9 *d.* and of the ſmall 24 *l.* 6 *s.* 3 *d.*

Allowing of the Shanks as Squares, the Area of the biggeſt Anchor is 40 Inches, which being × by 18. 6. is 8880 Inches, and that ÷ by 144. is 61 $\frac{6}{10}$ for the Area; then the leaſt is 22. 4. which × by 10. 8. is 2867. and that ÷ by 144. is 19 $\frac{9}{10}$, the Area of the ſmall Shank or Content.

The Weights are one to another as 25 to 4, or more than as 6 to 1; but the Superficial Area's are one to another as 34 to 11, or near as 3 to 1; the Price allowed of is as 37 to 3, or near as 12 to 1; which Price I ſhall farther conſider of as follows.

Firſt, the Weight is as 6 to 1, and ſo the Waſte in the Iron may be expected to be, of which I cannot abſolutely allow, ſince I am apt to believe, that the greateſt Cauſe of making Waſte muſt be by the Hammer Strokes, or Percuſſion of the Smith; the outer Cruſt of the Iron ſcaling off is diminiſhed from the Weight of the Metal; notwithſtanding the Scales are not wholly Waſte, but in ſome caſes uſeful, as well as the Cinders and Duſt, which are Dregs of the Coals; but this only by way of letting the Smith ſee that all is not wholly loſt, that he pretends is waſted by Forging Iron: But to proceed, I ſhall at preſent allow that this Waſte ſhall be according to the Weight of the Iron, which indeed is the moſt that ever the Smith can deſire to be given to him, and then the Proportion of Waſte between the two Anchors mention'd will be as 6 to 1; but the Workmanſhip can be allowed no otherwiſe than as the Superfices are one to another, which is as 3 to 1, and the faſhioning Part equal, ſince there will be actually as much Curioſity required in Shaping the ſmall Anchor, as in Shaping the great Anchor.

But before I proceed to the Workman's Labour, I ſhall be ſomething particular in the Waſte, becauſe it is the greateſt Pretence the Smith has to hold up and require ſuch an extraordinary Price for his wrought Iron, in Proportion to what it firſt coſt him.

The Opinion of Smiths in this Point is very various; ſome will avouch, that the Waſte in ſome Iron is 18 or 20 Pound in One Hundred Pound, which is near $\frac{1}{5}$ Waſte; others will tell you it's $\frac{1}{4}$; ſome ſay $\frac{1}{6}$ or $\frac{1}{7}$, and ſome ſay 'tis but $\frac{1}{20}$ Part, that is abſolutely loſt in Forging rough Work; which Proportions and Opinions in the Waſte are really very wide, as from 5 Pound to 20 Pound in One Hundred Weight, or 112 Pound; and this Diverſity in Judgment ſeems as if they were Forging Lyes as well as Forging Iron, otherwiſe they know not their Buſineſs; and as I have hinted, ſuch a Waſte is made through Diſability in the Working Man, which ought to be prevented; beſides, if the Iron is not melted into the Fire, then the Waſte that happens will appear on the Ground as Scales, and may be ſoon adjuſted; but if it be melted into the Fire (as ſeems to me very unlikely) then it will be very probable that the Shape of the Anchor will be ſpoiled, by ſome ſudden Wants that may happen more in one place than another, by ſuch a melting of the Iron.

But perhaps the Smith means by Waſte, ſuch Parts as at divers times he is obliged to cut off to fit and ſhape his Work; and if it be ſo, perhaps the Waſte may come to 18 Pound in 112 Pound, and in other Work the Waſte may come under 5 Pound in every 112 Pound, which ought (as I ſaid before) to be charged on the inſufficiency of the Purveyor, for not providing his Iron more ſuitable according to the Nature of his Work.

However, in Conſideration of ſuch large Work and over-heat, which may be required to make the Parts fitting for weilding, I ſhall allow that in the largeſt Anchors the Waſte ſhall be $\frac{1}{8}$ Part; ſo that in the Anchor of 71 Hundred 2 Quarters, the Waſte I allow to be 9 Hundred, or that there may be provided in the Hoops to Forge ſuch a large Anchor 80 Hundred Weight of Iron, which at 18 *s.* 8 *d. per* Hundred, is 74 *l.* 13 *s.* 4 *d.* not that it is reaſonable for the Smith ever to deſire ſuch a Price throughout for his unwrought Iron; and what is converted or compoſed to make ſuch large Anchors, ſince the ſmalleſt Pieces (that perhaps the Smith may in diverſe Caſes term Waſte) are not loſt, will be every whit as uſeful for Forging ſuch large Anchors as the biggeſt Bars; which Obſervation will in ſome Meaſure be made good by a common ſaying, That the largeſt Anchor would be much the better if it was made with Hob-Nails, or the ſmalleſt Pieces of Iron that could be got. But to proceed and conſider of the neceſſary Charges which will be requiſite in Forging Anchors.

Firſt, obſerving the Weight of the Parts, I ſhall allow that the Shank of an Anchor ſhall be $\frac{9}{14}$ of the whole Weight, and each Flook $\frac{2}{14}$, and the Ring $\frac{1}{14}$; but in Conſideration of the Work in the Flooks and the Arms of an Anchor more than in the other Parts, I ſhall divide the Workmanſhip into 4 Parts; and in that Diviſion I allow the Shank, the Ring, and putting the Ring into the Hole 2 Parts, and for each Arm and ſhuting the Arm on to the Shank 1 Part; ſo that each Part muſt be equal to the Working of 18 Hundred Weight of Iron.

The Number of Men to manage this Work I allow to be 11 Hammer-Men at 12 *s. per* Week each, beſides one Foreman at 24 *s. per* Week; and for Beer allowing each Man 1 Gallon a Day, the Charge will be 16 *s.* a Week; ſo that there will be 8 *l.* 12 *s.* a Week allowed for Men's Wages and Beer.

Memorandum, That the Weight of 1 Foot Length of the biggeſt Anchor Shank is 160 Pound, and the Weight of the Coals ſuitable is 2900 Pound, which is 30 Buſhels 1 Gallon $\frac{2}{7}$.

To go on, according to my former Calculation for ſmall Work, and making a Fire ſuitable to the Bigneſs of the Anchor Shank, the Fire would take up 30 Buſhels of Coals, and make ſuch a Fire that no Man living would be able to ſtand to tend it, and therefore I ſhall rather chooſe to divide the Coals approved of into moderate Fires, as Men may be able to give true Attendance, to maintain and do their Labour; then there being 80 Buſhels and 5 Gallons allowed for the whole great Anchor, I ſhall divide the whole Quantity into 12 Parts, or 12 Days Work, and leave the Quantity of Coals to be put on at one time to the Judgment of the Artificer; and this I well know to be moderate and reaſonable Allowances, and what 11 Men to hammer and one to direct will comply with, ſince it is but 6 Hundred Weight each Day, or half a Hundred Weight each Man, which is but $\frac{1}{10}$ Part of what a Man and a Boy may do in ſmall Work; I will allow for Wear and Tear and Uſe of Anvils, Bellows, and Sledges (as the Smiths term their Hammers) 5 *s. per* Hundred, which in making ſuch a large Anchor will be 17 *l.* 5 *s.* and ſo I proceed to the Grand Sum.

	l.	*s.*	*d.*
The Iron at firſt is to be 80 Hundred Pound Weight to make an Anchor of 71 Hundred 2 Quarters at 18 *s.* 8 *d. per* Hundred, for Rude Iron, the Sum is	74	13	4
For Coals to Forge, allowing the Weight equal to the Iron —	3	6	$3\frac{1}{4}$
For Men's Wages at the Rate as aforeſaid, end Beer ——	17	4	0
For the Uſe of Anvils, Bellows, and all Tools —— ——	17	5	0
The Total Sum neceſſary is ——	112	8	$7\frac{1}{4}$
The Total Sum allowed as Cuſtom is ——	292	15	0
Remains over and above what is reaſonable ——	180	6	$4\frac{3}{4}$

I now proceed to make a Calculation for the ſmall Anchor, in which I ſhall allow the Waſte to be in Proportion to the Weight of each Anchor; ſo that if 71 Hundred 2 Quarters require 8 Hundred 2 Quarters, what ſhall 11 Hundred 2 Quarters require? And it requires 1 Hundred 1 Quarter 16 Pound, which added to 11 Hundred 2 Quarters, is 12 Hundred 3 Quarters 16 Pound, at 18 *s.* 8 *d. per* Hundred is 11 *l.* 18 *s.* 8 *d.* I allow of the Workmanſhip to be as 3 to 1, whether it be in leſſening the Men or the Time, it matters not much; however, it's my Opinion to leſſen the Men, or reduce the Number, and continue the Time; but then the Smith may object, that if you make the Anchors at the ſame Fires, the Uſe of Bellows will be the ſame in making the ſmall Anchor as in making the great Anchor; but then the Uſe of Sledges will be leſs. The Iron at firſt is to be 12 Hundred 3 Quarters 16 Pound, to make an Anchor of 11 Hundred 2 Quarters.

	l.	*s.*	*d.*
Iron at 18 *s.* 8 *d. per* Hundred, will be ——— ———	11	18	3
For Coals to Forge, allowing the Weight as the other ——	0	10	7½
For Men's Wages and Beer, as aforeſaid —— ——	5	14	8
For the Uſe of Anvils, Bellows, and all Tools —— ——	5	15	0
The Total Sum neceſſary ———	23	18	6½
Total Sum allowed as Cuſtom —— ——	24	6	3
Remains over and above what is reaſonable ——	0	7	8½

In this Calculation I allow the Labour and Uſe of Tools ⅓ of the great Anchor's Charge.

And in this I believe the Smith will be apt to ſay (what is ſaid in other Caſes) that he loſes by ſome Anchors, and gets by others; but then the Severity falls chiefly upon large Anchors, and indeed much larger than what is made uſe of in the Merchant's Service; ſo that the Owners of the private Ships will have no Reaſon to complain or pry into this Matter, and ſee that in one Anchor a Man may very well gain 150 *l.* and in another Anchor, every way made alike, that he ſhall get never a Farthing, and yet all one Man's Contract, and the Work performed at the very ſame Shop: And now I ſhall paſs on in the next Place to conſider of a Method to prove the Goodneſs and Strength of Anchors.

But firſt I ſhall juſt hint my Opinion, what the large Prices for making of great Anchors was allowed for.

In one Caſe I preſume this great Price was allowed the Smith for his extraordinary Care in providing the beſt of Iron, and after ſuch Proviſion to ſee that ſuch Iron was well weilded together, without the leaſt Defect; for if ſuch a Cuſtom was complied with, as to put the Bars together one by one, that a Surveyor might ſee plainly they were nicely interwoven without any Flaws or intervening Parts, it would really have ſwell'd a Charge, and perhaps come up near to that very large Allowance which was actually made him; but to put all the Bars together that were requiſite to compoſe ſuch and ſuch an Anchor, and then to Weild them at one ſingle Heat, will be allowed of no bigger Value than what I have before mention'd.

In another Caſe this great Price muſt be allowed the Smith for undergoing Tryals to prove his Anchors; nay, he may afford to provide an Engine to prove them, and alſo be at the Charge of making the Proof; but then it ought to be mentioned in his Contract, both as to the Nature of the Engine, and alſo the Manner of the Tryals; of which I will give my Opinion freely.

All Tryals ſhould be made according to the Natural Strain requiſite in the Material; that is, as near as poſſible to apply the Strength and Strain at ſuch Tryals, equal in every reſpect to that Weight or Power which will be placed unto or upon it, when the Utenſil comes to it's Uſe, and therefore in the Tryals of Anchors (in my Opinion) they ought to be proved three different ways.

Firſt, in their falling from the Ship's Bow; ſecondly, as to their Straining by the Ship's Riding at Anchor; and thirdly, in weighing of the Anchor, and bringing of it to the Bow again.

Firſt, as to letting the Anchor fall from the Bow, the Strain will be found very inconſiderable, ſince every Body is lighter in the Water than in the Air,

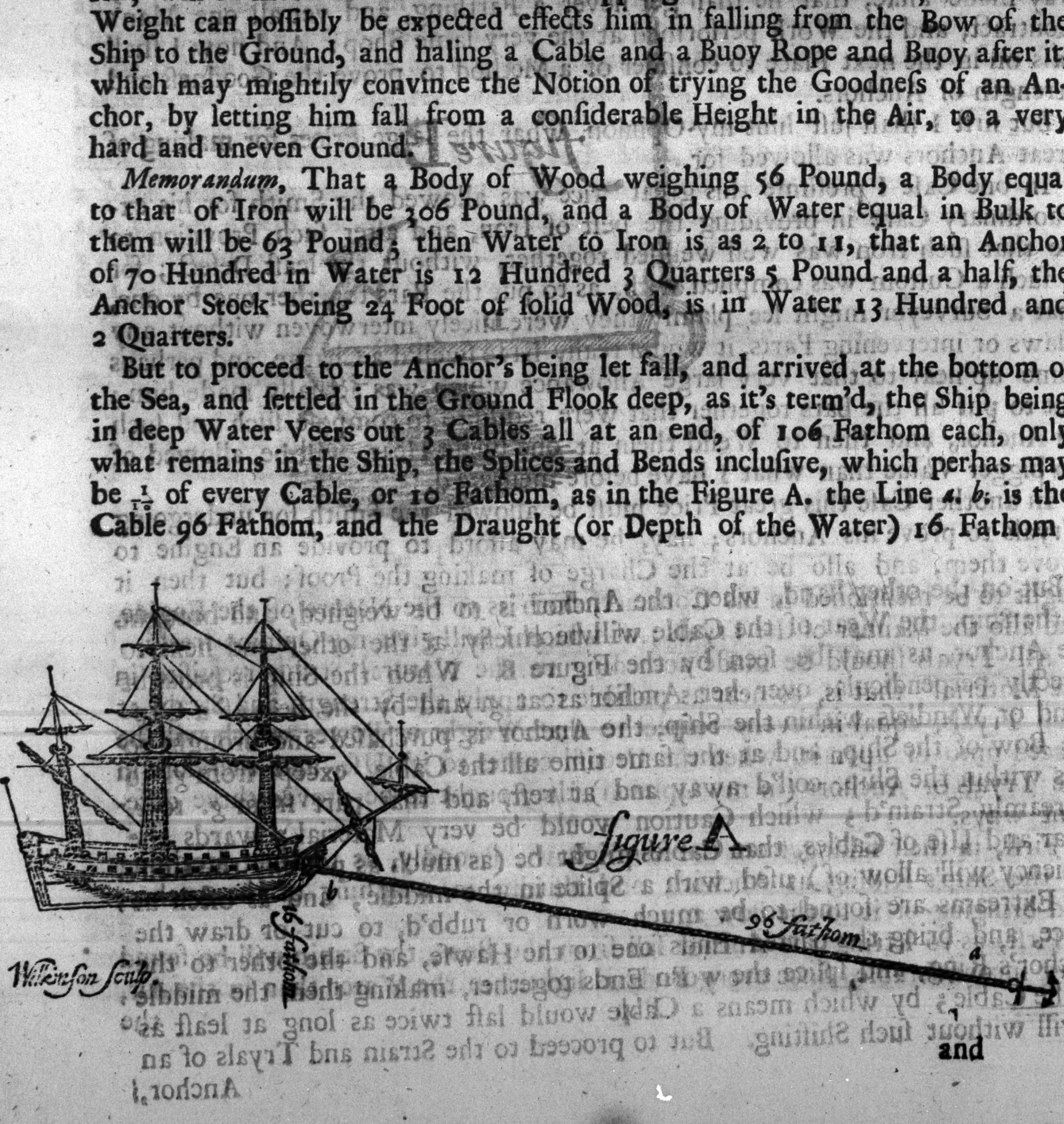
the

the Anchor will be ſo by Conſequence, as you may more plainly obſerve in the Honourable *Robert Boyle*'s Hydroſtaticks, that in ſome Caſes an Anchor may be imagined to Swim, and doubtleſs would do ſo at ſome Depths, was it not for the Incumbent Water that Weighs upon it when its beneath the Top Surface 19 or 20 Fathoms, as I ſhall endeavour to prove by one Example.

Let there be an Anchor of 70 Hundred Weight to be lower'd to the Ground in any Draught of Water, with a ſizable Cable made faſt to it as uſual, the Body of Water which the Anchor diſplaces will be equal to 12 Hundred 3 Quarters 5 Pound and a half Weight, and the Water that the Anchor Stock diſplaces will be equal to 13 Hundred 2 Quarters, which two Sums put together will be 26 Hundred 1 Quarter 5 Pound and a half; ſo that at ſuch an Anchor's firſt plunging into the Water it will be 26 Hundred 1 Quarter 5 Pound and a half lighter than it was in the Air, only 3 or 4 Pound to be abſtracted for the $\frac{1}{800}$ Part, or that Difference there is between the Weight of Water and Air; ſo that the Anchor inſtead of 70 Hundred Weight will be but equal to 43 Hundred 2 Quarters 22 Pound and a half, which Difference is what the Weight really is, and what it may be expected to be, and in all likelyhood the Neglect of ſuch ſolid Reaſoning may be the Cauſe why Anchors are often found too light for their reſpective Cables, and have not Gravity enough to carry themſelves to the Ground; and from ſuch Obſervations it will appear, that the fall of Anchors is very inconſiderable to the Principal Strain, ſince the drawing out the Cable will be almoſt equal to the incumbent Water, and that the falling of a very ſmall Weight in the Air, will be more detrimental to the crippling of ſuch an Anchor, than what Weight can poſſibly be expected effects him in falling from the Bow of the Ship to the Ground, and haling a Cable and a Buoy Rope and Buoy after it, which may mightily convince the Notion of trying the Goodneſs of an Anchor, by letting him fall from a conſiderable Height in the Air, to a very hard and uneven Ground.

Memorandum, That a Body of Wood weighing 56 Pound, a Body equal to that of Iron will be 306 Pound, and a Body of Water equal in Bulk to them will be 63 Pound; then Water to Iron is as 2 to 11, that an Anchor of 70 Hundred in Water is 12 Hundred 3 Quarters 5 Pound and a half, the Anchor Stock being 24 Foot of ſolid Wood, is in Water 13 Hundred and 2 Quarters.

But to proceed to the Anchor's being let fall, and arrived at the bottom of the Sea, and ſettled in the Ground Flook deep, as it's term'd, the Ship being in deep Water Veers out 3 Cables all at an end, of 106 Fathom each, only what remains in the Ship, the Splices and Bends incluſive, which perhas may be $\frac{1}{10}$ of every Cable, or 10 Fathom, as in the Figure A. the Line *a. b.* is the Cable 96 Fathom, and the Draught (or Depth of the Water) 16 Fathom;



and with 3 Cables at an End or veer'd out of the Ship, the Angle will be the ſame in 48 Fathom Water, or near an Angle of 10 Degrees; which large Lengths in Cables undeniably facilitate the Strain of the Anchor, and as it's term'd, cauſes the Ship to Ride eaſie, not ſtraining the Cable or Anchor near ſo much, as when a Ship Rides ſhort, and has but little Cable out.

I ſay a Ship Riding with all her 3 Cables out, or but one in Shoal Water, will Ride out a great Storm, and the Cable but very little affected, except it be the Part near the Hawſe Hole, provided the Anchor be ſufficient and well ſettled in the Ground, for the very Weight in Cables by ſuch extream Length, is very aſſiſting towards holding the Ship; for altho' a Ship at ſome times by the Violence of Wind and Sea ſeems to Strain and Tug very hard upon her Cable, yet when ever the Cable by it's over Weight and Strength becomes an over Match for that Violence of the Wind and Sea, the Ship is not only ſtopt, but is alſo drawn towards her Anchor, and at the ſame time the Cable is not equally affected (in every Part) by ſuch extream Tugging, nor indeed ſcarce any where, except a few Fathom near the Hawſe Hole, and at the Bits where it is belayed.

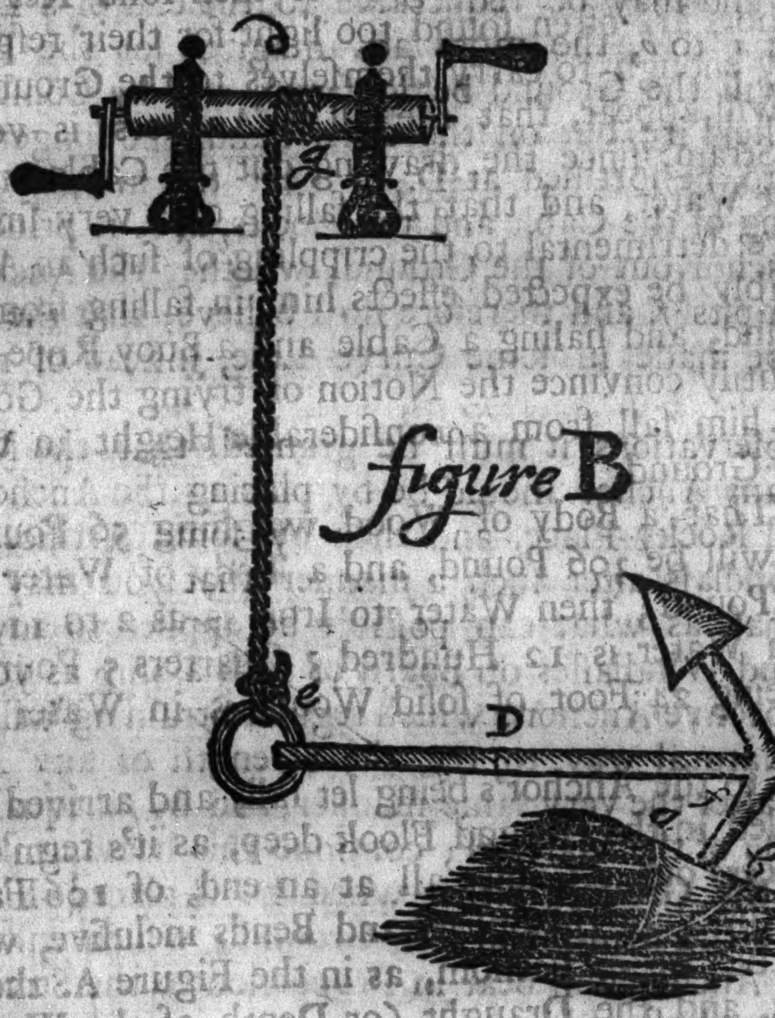


figure B

But on the other hand, when the Anchor is to be weighed, and brought to the Ship, the Wear of the Cable will be chiefly at the other end next to the Anchor, as may be ſeen by the Figure B. When the Ship is brought directly perpendicular over her Anchor as at *g.* and by the help of a Capſtand or Windleſs within the Ship, the Anchor is purchaſed and brought to the Bow of the Ship, and at the ſame time all the Cable, except from *g.* to *e.* is within the Ship, coil'd away and at reſt, and that part from *g.* to *e.* extreamly Strain'd; which Caution would be very Material towards the Wear and Uſe of Cables, that Cables might be (as much as poſſibly the Conveniency will allow of) uſed with a Splice in the middle, and as often as the Extreams are found to be much worn or rubb'd, to cut or draw the Splice, and bring the parted Ends one to the Hawſe, and the other to the Anchor's Ring, and ſplice the worn Ends together, making them the middle of the Cable; by which means a Cable would laſt twice as long at leaſt as it will without ſuch Shifting. But to proceed to the Strain and Tryals of an

Anchor, which will be found moſt Material at weighing, as may be ſeen in the Figure B. for I have experienced in a Ship of 1000 Tuns, that after She has Rid 2 or 3 Days in *Solebay*, with as much Wind and Sea as any Ship could poſſibly Ride in or endure, that at the heaving up of the Anchor by a vaſt Purchaſe (the Anchor was ſo well ſettled in the Ground) that the Iron has parted) nothing being brought up but half the Ring of the Anchor, altho' the Ship Rid faſt, and ſeemingly ſure as long as the Cable was out to the greateſt Drift.

The greateſt Strain (in my Opinion) of any Anchor is at 3 Places, as in the Figure B. which is either at *D.* or near the middle of the Shank, elſe at *b.* or near the upper end of the Flook, where an Anchor in hard Ground is generally ſettled into it; or otherwiſe at *f.* where the Arm is ſhut on to the Shank, and where an Anchor may probably be ſunk into ſoft Ground (as Mud) to that Depth.

For let it be ſuppoſed, that any Anchor may be ſettled into the Ground Flook deep, or to *a. b.* the Ship's Crew endeavouring to Purchaſe the Anchor after a Storm, heaves a Peak, or perpendicular over her Anchor, as at *g.* and then being forced to apply a very great Purchaſe to Weigh the Anchor out of the Ground, and may be reduceable to the end of a Leaver, which the longer it is from *a* to *b*, the more advantagious for the Eaſe of the Cable, and the ſooner will the Ground be looſened, and by Conſequence the Flook clear'd of what held it; but on the other hand, the longer the Leaver is the better it ought to be fortified at D. or near the middle of the Shank, between the bending of the Cable and the Flooks, *a. b.* is principally affected by weighing the Anchor out of the Ground, whether the Anchor is Flook deep, or up to the Armpits *f.* and therefore do I believe, that the Shank of any Anchor ought to be made in ſome Curve Line, inſtead of making it directly Straight.

From ſuch Obſervations it muſt be granted, that the Method for trying the Strength of any Anchor ſhould be by placing the Anchor firſt Flook deep into a good hard Rocky Place, and then by ſome Artifice, as at *g.* place a Capſtand or Windlaſs after ſuch a manner that you may be able to heave as great a Purchaſe as what can poſſibly be applied to any Capſtand, or all the Capſtands and Windlaſſes on Board of ſuch a Ship as you are making the Tryal on her reſpective Anchor; which regular Straining will be far pleaſanter, and the moſt Natural way to try the Strength of any Anchor, ſince you apply the Power after the very ſame manner, and by an equal Strength of what is done in the Uſe of the Material; continue this heaving until the Anchor is weighed out of the Ground, either when he is placed Flook deep in hard Ground, or up to the Arm-pit in ſoft Ground; which will plainly ſhew you what Strain any Anchor will bear in Proportion to the Strength you can apply to him on Board of a Ship.

Not that there will be a Neceſſity to have ſuch an exact Number of Men attending ſuch Tryals, as are always ready on Board of a Ship, for that may be made up by the Faſhion of a Machine you deſign for the Tryals, as I have obſerved the Shape of an Engine in Mr. *Evelyn*'s *Sylva*, that he calls the *German Devil*, and propoſing it uſeful to hale up very large Roots of Trees, which I preſume a great deal harder than to break the biggeſt Anchor.

And if the Anchors will undergo ſuch Tryals, it will be no matter to try them according to the manner of the Strain cauſed by a Ship's Riding at an Anchor; for as I have mentioned before, when a large parcel of Cable is out, the Anchor is but little affected by the Strain of a Ship's Riding, altho' She Rides in a very great Storm both of Wind and Sea.

OF

OF CALKING.

THE Calkers in Sacred Hiſtory are termed wiſe Men of *Gabel*, which ſeems to import more than an ordinary Care that is requiſite in that particular Branch of Ship building, although in ſome Countries, (and in divers other Caſes) Wood can be made to hold Liquors, without driving Oakham into the Chinks or Seams,

Notwithſtanding this Faculty of Calking may throughly convince any unprejudic'd Man, that Timber and all ſuch Materials may be as nicely inſpected into, and a juſt Separation may be made of defective Timber from that which is fitting for Uſe, as well at the firſt receiving, as at it's being finiſhed and calked. This Faculty of Calking will alſo be reducible to that Mechanick Power, the Wedge, ſince it's no other in the ſtricteſt Senſe, than forcing by driving ſmall Wedges into the Crannies, and filling up the Wants or Vacuities, (made by Joyning the Plank) with unravell'd Hemp, or what Shipwrights term Oakham, though there be ſeveral other porous Places in Planks and Boards, (termed Shaus and Shakes) which muſt be filled up with Oakham, before our Country Ships will be fitting for Service, and the Water be kept out of the Cavity of the Ship.

The Trenels or Pins that the Planks are faſten'd with, muſt be alſo Calked, although drove as ſtiff as they can be drove with Mauls.

I was ever of Opinion, and could never perſwade myſelf otherwiſe, that running over a Multitude of Work, without regarding the well doing of it, was neither Advantagious nor Profitable, but on the other Hand a Hindrance to the Diſpatch, and Deſtructive to the good Diſpoſition of the Machine.

I ſhall therefore ſhew how Detrimental it is in this Branch of Calking, and afterwards give my Opinion how it may be remedied with Advantage.

It being generally obſerved, though much to be wiſhed otherwiſe, that both in the Publick, and alſo in Private Buſineſs, the Perſon that doth the moſt Work, though never ſo ordinary, is counted the beſt Man; nay, ſo much farther it is, that he who cannot do a great deal, or Task, may be ſtarved; as in planking Ship's Bottoms, the making nice, regular and equal diſtant Seams, is not minded, but in ſome Places the Edges ſhall cloſely meet, and in other Places at a great Diſtance.

Indeed in Calking there is ſomething minded, but whether it be Rule or Fancy, I cannot directly ſay, but ſhall conſider them in the following Method.

Firſt, I will inſert the accuſtomary Table, or the general Calculations approved of by the publick Vogue, for Calking above Water and under Water, alſo for graving or dreſſing any Ship with Pitch, Tar, Rozam, Tallow and Oakham, *&c.*

An Account of the Materials fitting to Grave a Ship of Seven ſeveral Rates.

Sizes.	Tunn.	Rozam		Oyl.		Brim-ſtone.		Thrum		Twine		Lea-ther.		Reed.	
Firſt	1700	20	Hundred Weight	55	Gallons.	3	Hundred Weight	25	Pounds.	2	Pounds.	2	Pounds.	3200	Sheaves.
Second	1400	17		44		$2\frac{1}{2}$		20		$1\frac{1}{2}$		$1\frac{2}{8}$		2800	
Third	1000	14		36		2		16		$1\frac{1}{4}$		$1\frac{1}{4}$		2500	
Fourth	600	8		19		$1\frac{1}{2}$		12		1		1		1600	
Fifth	350	7		$17\frac{1}{2}$		$1\frac{1}{4}$		11		$\frac{3}{4}$		$\frac{3}{4}$		1400	
Sixth	250	4		10		$\frac{3}{4}$		8		$\frac{1}{2}$		$\frac{1}{2}$		800	
Seventh		3		$7\frac{1}{2}$		$\frac{1}{2}$		6		0		0		600	

The Continuation of the aforegoing Table.

Sizes.	Tunn.	Broom if no Reed.		Sweeping Brooms.		Pitch.		Burning Poles.		Double Buckets.		Men.	
Firſt	1700	2800	Bavins.	9	Dozens.	5	Hundred Weight	24	Number.	20	Number.	30	Number.
Second	1400	2400		8		4		19		17		25	
Third	1000	2000		7		3		17		14		20	
Fourth	600	1400		5		$1\frac{1}{2}$		12		8		15	
Fifth	350	1200		4		$1\frac{1}{4}$		10		7		11	
Sixth	250	600		3		$\frac{3}{4}$		6		4		7	
Seventh		400		2		$\frac{1}{2}$		4		3		5	

An Account of Materials fitting to Calk a Ship of each Rate from the Water upwards.

ize.	Tunn.	Black Oakham.		White Oakham		Oyl.		Pitch.		Tar.		Thrum		Lea-ther.	
Firſt	1700	20	Hundred Weight	5	Hundred Weight	18	Gallons.	6	Barrels.	2	Pounds.	14	Pounds.	1	Pounds.
Second	1400	16		4		16		5		2		13		1	
Third	1000	13		3		13		4		$1\frac{1}{2}$		11		1	
Fourth	600	10		$1\frac{1}{2}$		10		3		1		9		$\frac{3}{4}$	
Fifth	350	7		1		7		$2\frac{1}{2}$		1		7		$\frac{3}{4}$	
Sixth	250	4		$\frac{1}{2}$		4		2		$\frac{3}{4}$		4		$\frac{1}{2}$	
Seventh		2		$\frac{1}{4}$		2		1		$\frac{1}{2}$		3		$\frac{1}{2}$	

The Continuation of the aforegoing Table.

Size	Tunn.	Twine		Can-dles.		Buckets.		Laſhing.		Deals.		Workman-ſhip.	
Firſt	1700	1	Pounds.	16	Pounds.	8	Number.	2	Coils.	30	Number.	47	Pounds Sterling.
Second	1400	1		15		7		2		30		45	
Third	1000	1		12		6		$1\frac{1}{2}$		24		40	
Fourth	600	$\frac{3}{4}$		9		5		1		20		35	
Fifth	350	$\frac{3}{4}$		7		4		1		16		28	
Sixth	250	$\frac{1}{2}$		3		3		$\frac{1}{2}$		10		15	
Seventh		$\frac{1}{2}$		2		2		$\frac{1}{2}$		6		9	

The Charge of Materials and Workmanſhip for the Calking and Graving of any Ship, from one of the firſt Magnitude, to one of Tuns, in the Year 1674.

	First Size 1700 Tuns.			Second Size 1400 Tuns.			Third Size 1000 Tuns.			Fourth Size 700 Tuns.		
	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Charge of the Upper Work	75	17	6	72	7	1	59	17	3	53	12	9
Charge of the cleaning under Water.	40	12	3	34	4	10	27	2	2	25	13	11
Sum Total	116	9	9	106	11	11	76	19	5	76	6	8

	Fourth Size 500 Tuns.			Fifth Size 350 Tuns.			Sixth Size 250 Tuns.			Seventh Size 150 Tuns.		
	l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Charge of the Upper Work	48	19	11	31	00	11	21	17	6	13	03	0
Charge of the cleaning under Water.	17	11	9	14	06	3	8	15	6	6	06	7
Sum Total	66	11	8	45	07	2	30	13	0	19	09	7

The Price and Rates of the Materials was then as follows; Rozam 12 *s.* per Hundred Weight, Oyl 2 *s.* 6 *d.* per Gallon, Brimſtone 18 *s.* per Pound, Pitch 13 *s.* per Barrel, Thrums 9 *d.* per Pound, Twine 1 *s.* per Pound, Leather 12 *s.* per Pound, Reed at 40 *s.* per Thouſand, Brooms 1 *s.* per Dozen. Burning Poles at 4 *d.* each, double Buckets, 1 *s.* 6 *d.* each, black Oakham 10 *s.* per Hundred, white Oakham 15 *s.* per Hundred, Tar 20 *s.* per Barrel, Candles 4 *s.* 6 *d.* per Dozen Pound, Laſhing 20 *s.* a Coil, and Deals at 12 *d.* each.

The Cuſtomary Allowance for Calking Plank from 10 Inches thick, to 1 Inch and a half thick.

Thick in Inches	Threads of Black Oakham.	Threads of White Oakham.	Hair.	Length of Seam for one Day Work		Length of Seam for one Tides Work	
	Nº Sing.	Nº Doub	Nº	Feet	Inches.	Feet	Inches
1 ½	1	1	0	43	0	8	6
2	1	1	0	32	0	6	6
3	2	2	1	23	0	4	6
4	2	3	1	18	0	4	0
5	3	3	2	16	6	3	6
6	4	4	2	16	0	3	0
7	5	4	2	15	0	3	0
8	5	5	2	14	6	2	9
9	5	6	3	14	0	2	9
10	6	6	3	13	6	2	6

Note, That theſe Rules are in Calking under Water, but above Water, and within Board, they never drive any Hair, the Hair being only to prevent the Bulg-Waters rotting the Oakham; alſo they never drive in the thickeſt Plank within Board above Water, more than 2 double Threads of black Oakham, and 2 Threads of white Oakham, nor leſs than one ſingle Thread in the thinneſt Plank.

The Number of Men, and the Time requiſite to Calk each Size.

Size.	Men.	Days	Size.	Men.	Days.
Firſt	30	50	Fourth	20	20
Second	30	40	Fifth	5	20
Third	24	30	Sixth	2	20

For Tallowing and Graving under Water, the Allowance for a Ship of each Rate is as follows.

Rates.	Tallowing.			Blacking.			Graving.						
				Pitch	Tar	Blacking	Brimſtone			Rozam.			Oyl.
	C.	q.	l.	Barrels.	Bar.	Barrels.	C.	q.	l.	C.	q.	l.	Gal.
Firſt	18	0	0	12	6	6	3	3	0	30	0	0	40
Second	14	0	0	8½	4	4	3	0	0	24	2	0	30
Third	11	0	0	6	3	3	2	2	0	19	0	0	25
Fourth	8	2	0	5	2½	2½	1	3	0	14	2	0	20
Fifth	6	0	0	4	1½	2	1	1	0	10	2	0	14
Sixth	4	2	0	3	1½	1½	1	0	0	7	2	0	10

Materials allowed for Graving the *Soasdike* Yatch of near 120 Tuns.

	C.	q.	l.	
Rozam	4	0	0	
Brimſtone	0	2	0	
Thrums	0	0	8	
Leather	0	0	1	
Twine	0	0	½	
Oyl	10			Gallons
Single Brooms	30			Number
Old Enſign	1			Number
Double Buckets	1			Number
Small Spars	2			Number
Stup in lieu	1			Number
Old 6 Inch Rope	2			Fathoms

I proceed now to ſhew how theſe Materials are proportion'd one to another, that ſo may be ſeen the Reaſonableneſs of their Mixtures in former Times.

The Proportion of Rozam is	The firſt Size to the ſecond is as — —	7 to 6
	The firſt Size to the third is as — —	10 to 7
	The firſt Size to the fourth is as — —	18 to 8
	The firſt Size to the fifth in as — —	17 to 6
	The firſt Size to the ſixth is as — —	5 to 1

The Proportion of Oyl is accordingly as	10 to 8	The Proportion of Brimſtone is accordingly as	6 to 5
	3 to 2		3 to 2
	17 to 7		11 to 6
	19 to 6		12 to 5
	11 to 2		8 to 2

The Proportion of the Pitch is	The firſt Size to the ſecond is as — —	5 to 4
	The firſt Size to the third is as —	5 to 3
	The firſt Size to the fourth is as — —	10 to 3
	The firſt Size to the fifth is as — —	8 to 2
	The firſt Size to the ſixth is as — —	20 to 3

The Proportion of Thrums is accordingly as	5 to 4	The Proportion of Twine is accordingly as	4 to 3
	11 to 7		8 to 5
	25 to 12		2 to 1
	9 to 4		8 to 3
	22 to 7		4 to 1

The Proportion of the Leather is	The firſt Size to the ſecond is as —	4 to 3
	The firſt Size to the third is as — —	8 to 5
	The firſt Size to the fourth is as — —	2 to 1
	The firſt Size to the fifth is as — —	8 to 3
	The firſt Size to the ſixth is as — —	4 to 1

The Proportion of Sheaves of Reed is accordingly as	9 to 5	The Proportion of Broom-Bavins is accordingly as	7 to 6
	15 to 7		7 to 5
	2 to 1		2 to 1
	16 to 7		7 to 3
	14 to 1		14 to 3

The Proportion of Brooms to ſweep with is	The firſt Size to the ſecond is as —	9 to 8
	The firſt Size to the third is as —	9 to 7
	The firſt Size to the fourth is as —	9 to 5
	The firſt Size to the fifth is as — —	9 to 4
	The firſt Size to the ſixth is as — —	3 to 1

The Proportion of Burning Poles is accordingly as	10 to 8	The Proportion of double Buckets is accordingly as	7 to 6
	7 to 5		10 to 7
	2 to 1		5 to 2
	12 to 5		17 to 6
	4 to 1		5 to 1

The Proportion of Men to all the other Proportions is as	6 to 5
	3 to 2
	2 to 1
	19 to 7
	30 to 7

And ſo Ends the Proportion of the firſt Table, wherein you may obſerve great Variety in the Allowance of the Materials, and that altho' the Work (and alſo the Superficies) is directly agreeable; yet the Mixtures and Implement will of courſe be quite otherwiſe; and ſo I proceed to the ſecond Table, wherein is ſhewn the accuſtomary Allowance of Materials and Workmanſhip to Calk any Ship of the ſeveral Sizes, and ſhall ſee how their Proportions bear one to another.

The Proportion of Black Oakham is	The firſt Size to the ſecond is as	5 to 4
	The firſt Size to the third is as	20 to 13
	The firſt Size to the fourth is as	2 to 1
	The firſt Size to the fifth is as	20 to 7
	The firſt Size to the ſixth is as	5 to 1

The Proportion of White Oakham is as	5 to 4	The Proportion of Oyl is as	9 to 8
	5 to 3		16 to 11
	10 to 3		9 to 5
	5 to 1		18 to 7
	10 to 1		9 to 2
The Proportion of Pitch is as	6 to 5	The Proportion of Tar is as	1 to 1
	6 to 4		4 to 3
	2 to 1		2 to 1
	12 to 5		2 to 1
	3 to 1		8 to 3
The Proportion of Thrums is as	14 to 13	The Proportion of Leather is as	1 to 1
	14 to 11		1 to 1
	14 to 9		4 to 3
	2 to 1		4 to 3
	7 to 2		2 to 1
The Proportion of Twine is as	1 to 1	The Proportion of Candles is as	16 to 15
	1 to 1		4 to 3
	4 to 3		16 to 9
	4 to 3		16 to 7
	2 to 1		16 to 3
The Proportion of Buckets is as	8 to 7	The Proportion of Laſhing Rope is as	1 to 1
	4 to 3		4 to 3
	8 to 5		2 to 1
	2 to 1		2 to 1
	8 to 3		4 to 1
The Proportion of Deals for Stages is as	1 to 1	The Proportion of Workmanſhip to all the other is as	21 to 20
	5 to 4		7 to 6
	3 to 2		4 to 3
	13 to 7		5 to 3
	3 to 1		27 to 7

So ends the Second Table: However, I ſhall ſhew ſuch Proportions in the Third, and firſt as to the Charge of Calking and Graving the ſix ſized Ships, that is, the Charge of Materials and Workmanſhip for Calking and Paying the Upper-work within-ſide and without-ſide, and alſo for Cleaning and Graving under Water.

Firſt, for the Charge of Materials and Workmanſhip to Calk and Pay the Upper-work, the Proportion will be

The firſt Size to the ſecond is as — 20 to 19
The firſt Size to the third is as —— 9 to 7
The firſt Size to the fourth is as —— 11 to 7
The firſt Size to the fifth is as —— 22 to 9
The firſt Size to the ſixth is as —— 18 to 5

Secondly, the Proportion for the Charge of Materials and Workmaaſhip to Clean and Grave under Water, which is as

6 to 5
3 to 2
7 to 3
20 to 7
5 to 1

The following Proportions are for Calking new Oak Plank from 1 Inch and a half thick to 10 Inches thick, with the Length of the Seam in each particular Plank, that ſhall be deem'd a Day's Work, and what a Tide's Work. Note, That 1 Hour and a half is a Tide, and 5 Hours a Day's Work, before or after *6* a Clock in the Morning or Evening.

The Proportions is are follows, and firſt for the Number of Threads in Black Oakham.

Threads in 1 Inch $\frac{1}{2}$ Plank to what is drove into 2 Inch Plank, is as 1 to 1.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into 3 Inch Plank, is as 1 to 2.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into 4 Inch Plank, is as 1 to 2.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into 5 Inch Plank, is as 1 to 3.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into *6* Inch Plank, is as 1 to 4.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove inth 7 Inch Plank, is as 1 to 5.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into 8 Inch Plank, is as 1 to 5.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into *9* Inch Plank, is as 1 to 5.
Ditto in 1 Inch $\frac{1}{2}$ Plank to what is drove into 10 Inch Plank, is as 1 to 6.

The Allowance of White Oakham and double Threads is as

1 to 1
1 to 2
1 to 3
1 to 3
1 to 4
1 to 4
1 to 5
1 to *6*
1 to *6*

The Proportion for the Length of the Seam that ſhall be Calked and deem'd one Day's Work.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 2 Inch Plank, are as *6* to 8.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 3 Inch Plank, are as 7 to 13.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 4 Inch Plank, are as 5 to 12.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 5 Inch Plank, are as 5 to 13.

The Feet to be Calked in 1 Inch and half Plank, to what is to be Calked in *6* Inch Plank, are as 3 to 8.

The Feet to be Calked in 1 Inch and half Plank, to what is to be Calked in 7 Inch Plank, are as 7 to 20.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 8 Inch Plank, are as 1 to 3.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 9 Inch Plank, are as 13 to 40.

The Feet to be Calked in 1 Inch and a half Plank, to what is to be Calked in 10 Inch Plank, are as 5 to 16.

The Proportion for the Tides ſhould be as 1 and a half is to 5 (or as 3 to 10) to what the Allowance is for the Days, according to my preceding Rule, ſince it's the $\frac{3}{4}$ Parts of one Night or Day's Work; but the common Allowance is near as 1 to 5. Then the Proportion for the Number of Men, and the Days that will be required to Calk a Ship, from one Size to the other, will be

The Proportion for the Number of Men will be	The firſt Size to the ſecond is as —— ——	1 to 1
	The firſt Size to the third is as ————	5 to 4
	The firſt Size to the fourth is as —— ——	3 to 2
	The firſt Size to the fifth is as —— ——	6 to 1
	The firſt Size to the ſixth is as —— ——	24 to 3

The Proportion for the Number of Men will be as	5 to 4
	5 to 3
	5 to 2
	10 to 1
	40 to 1

The Proportion of Men and Days put together is as	8 to 7
	6 to 4
	2 to 1
	16 to 5
	64 to 5

I proceed to the laſt Table, wherein is ſet forth the Allowance for Tallowing and Graving under Water, from a firſt Size Ship to a ſixth Size, and the Proportion is as follows.

The Proportion for the Tallow will be	The firſt Size to the ſecond is as —— ——	9 to 7
	The firſt Size to the third is as —— ——	13 to 8
	The firſt Size to the fourth is as —— ——	17 to 8
	The firſt Size to the fifth is as —— ——	3 to 1
	The firſt Size to the ſixth is as —— ——	4 to 1

The Proportion for the Black Pitch is as	7 to 5
	2 to 1
	12 to 5
	3 to 1
	4 to 1

The Proportion for Tar is as	3 to 2
	2 to 1
	12 to 5
	4 to 1
	4 to 1

The Proportion for the Blacking Barrels is as	3 to 2
	2 to 1
	12 to 7
	3 to 1
	4 to 1

The Proportion for the Graving, as particular the Brimſtone is as	5 to 4
	3 to 2
	15 to 7
	3 to 1
	15 to 4

The Proportion for the Rozam is as	11 to 9
	8 to 5
	25 to 12
	20 to 7
	4 to 1

The Proportion for the Oyl is as	11 to 9
	8 to 5
	2 to 1
	20 to 7
	4 to 1

Obſerving that the Tunnage of the ſix ſeveral Sizes mentioned according to the accuſtomary Method of Meaſure, will be, the firſt Size 1700 Tuns, the ſecond Size 1400 Tuns, the third Size 1000 Tuns, the fourth Size 600 Tuns, the fifth Size 350 Tuns, and the ſixth Size 250 Tuns; and in all which I ſhall refer it to your Obſervation of the Variety in the Proportion, and it may be term'd Shipwright's Rules for Calking, ſince the Calkers will allow that there can be no Rules given; but Calking muſt of Neceſſity depend wholly upon the Judgment of the Workman, or true Breed Calkers, as they term themſelves; notwithſtanding ſo far Calkers will allow, that there may be Methods found to know when Calking is well perform'd, and that is in two particulars.

Firſt, to know when the Oakham is well bottom'd, and firmly drove, will be to cut out a Piece in the Plank, where you may ſee how the Oakham lyes, and whether it is at the bottom or not; but to know this abſolutely, and in every particular part of the Ship, you muſt cut her to Pieces, and then you may alſo ſee whether the Oakham is well weaved and connexed together.

But in another caſe, they ſay to know this aſſuredly, whether the Calking is firm, is to Water the Ship, believing if Water will not run out of the Ship, it will not run into her.

However, declining the Calkers Rules in ſuch Caſes to be abſolute, I ſhall ſhew how the well Performance of Calking may be moſt nicely adjuſted, in order to which I ſhall firſt ſet down a ſuitable diſtance of the Seam in all ſorts of Planks, believing it to be highly neceſſary, that the Edging of all Plank be as dexterouſly perform'd, as tho' you was to joyn Casks or Brewers Coolers, which are made to hold Liquors without Calking; ſince the nicer any Material is wrought, the ſtronger it will be with leſs Subſtance, and that nothing can be ſo detrimental as ſudden Chops in Plank or Timber, as may be obſerved in cutting of Maſts by the Board; that one Chop with an Axe is more efficacious, in heaving the Maſt away, than a Top-ſail fill'd with Wind: And ſo I proceed to the Table for to ſhew the ſuitable Breadth of the Seams in any Thickneſs of Plank from 12 Inches thick to 1 Inch thick.

Inches. The Thickneſs of the Plank, from 12 Inches to 1 Inch and ½ thick.	Square Root of the Thickneſs.	The ⅛ of the Square Root of the Planks Thickneſs, which I deem proper for the Diſtance of the Butts Ends in each Thickneſs of Plank.	The Cube Root of the Planks Thickneſs.	The ⅛ of the Cube Root, which Fractional Parts I deem proper for the Diſtance between the Planks Edges (term'd the Seam) in each reſpective Thickneſs.
12	3 $\frac{46}{100}$	$\frac{43}{100}$	2 $\frac{29}{100}$	$\frac{29}{100}$
11	3 $\frac{31}{100}$	$\frac{41}{100}$	2 $\frac{22}{100}$	$\frac{28}{100}$
10	3 $\frac{16}{100}$	$\frac{40}{100}$	2 $\frac{15}{100}$	$\frac{27}{100}$
9	3	$\frac{37}{100}$	2 $\frac{8}{100}$	$\frac{26}{100}$
8	2 $\frac{83}{100}$	$\frac{35}{100}$	2	$\frac{25}{100}$
7	2 $\frac{64}{100}$	$\frac{33}{100}$	1 $\frac{91}{100}$	$\frac{24}{100}$
6	2 $\frac{45}{100}$	$\frac{31}{100}$	1 $\frac{82}{100}$	$\frac{23}{100}$
5	2 $\frac{24}{100}$	$\frac{28}{100}$	1 $\frac{71}{100}$	$\frac{21}{100}$
4	2	$\frac{25}{100}$	1 $\frac{59}{100}$	$\frac{20}{100}$
3	1 $\frac{73}{100}$	$\frac{22}{100}$	1 $\frac{44}{100}$	$\frac{18}{100}$
2½	1 $\frac{58}{100}$	$\frac{20}{100}$	1 $\frac{36}{100}$	$\frac{17}{100}$
2	1 $\frac{41}{100}$	$\frac{18}{100}$	1 $\frac{26}{100}$	$\frac{16}{100}$
1½	1 $\frac{22}{100}$	$\frac{15}{100}$	1 $\frac{14}{100}$	$\frac{14}{100}$
1	1	$\frac{12}{100}$ ½	1	$\frac{12}{100}$ ½

You may obſerve that the greateſt Diſtance in the Butt Ends in Plank of 12 Inches thick, is $\frac{43}{100}$ of an Inch, which is near ½ an Inch, and the ſmalleſt Diſtance in a Board of 1 Inch thick is $\frac{12}{100}$ ½ or ⅛ of an Inch.

And the greateſt Diſtance in the Seams in a Plank of 12 Inches thick, is $\frac{29}{100}$, or near $\frac{2}{7}$ of an Inch, and the ſmalleſt Diſtance in the Seams is the ſame with the Diſtance in the Butts; and the Reaſon why the Diſtance in the Butts is more than the Diſtance in the Seams in thick Plank, is by reaſon that the Plank or Timber will not yield Endwiſe ſo eaſily as it will Edgewiſe.

And by ſuch Methods nicely perform'd, may as exactly be known, what Oakham will fill or ought to be drove into a Ship, as to know how many Peas will fill a Pint Pot.

But firſt I have to conſider when Oakham can be ſaid to be well laid or coil'd into the Seam, and what Weight the Thread ought to be when it's well wove and connex'd together, and in ſuch a Caſe I am really of Opinion, if it be poſſible, (as I can ſee nothing to the contrary) the Weight of Oakham ought to be equal to as much Wood, as the Vacuity it's drove into contains, meaning the very ſort of Wood that bars the Seam or joyns to it on each ſide, whether it be Oak, Elm or Fir, and therefore there is no more to be done to know when any Ship is ſufficiently calked, than to compute the Weight of all the Vacuities or Crannies that's contain'd in all the Ship, which will give you exactly the Weight of the Oakham that ought to be drove into the Ship, whether it be black Oakham, white Oakham or Hair, which may very eaſily be done with a little Practice, ſince it will be an abſolute Method for the Seams, but for Rents and Trenels I ſhall in ſome Meaſure refer it to the Judgment of the wiſe Men of *Gabel*.

But to ſhew how far our preſent Practice is very defective, I ſhall proceed firſt by the Tables preceding, where you may obſerve, that ſuch and ſuch a Number of Threads of black Oakham, *&c.* is allowed to Calk each reſpective Rates; but the Method they took for ſuch Computation being no where to be met with, I ſhall inſtance what (in my Opinion) ſhould have been minded in making ſuch Tables.

Firſt their ſhould have been the Superficies of every Ship nicely taken, or at leaſt the Length of the Ship and Number of the Seams, and alſo the Thickneſs of the Plank, which would directly give you the Weight of the Oakham requiſite for Calking the Machine, and by that would be exactly known what Number of Men, and what Time will be required to perform ſuch a Task, and by the Superficies would be exactly known what Quantity of Pitch, Tar, Rozam, Oyl, Brimſtone, Tallow, and the like, which would be expended in covering the Ship, tho' indeed in ſome Meaſure there will be Variety in the Expence, according to the Time and Seaſon, as in warm Weather the Materials will go much farther than in dirty cold Weather, and therefore it will be highly neceſſary to fit Ships in the Summer Seaſon, and as much as poſſible in fine clear Weather.

Minding withal, that the Practice of rough chopping Planks Edges is very pernicious in divers Caſes, as in one it hinders the Workman, and ſtops him at ſuch ſudden Chops, obliging him in ſome Places to add to his Number of Threads, and at others he is forc'd to reduce the firſt Number, which muſt of Conſequence cauſe a Weakneſs not only in the Body of Oakham, but alſo in the Plank itſelf, and ſo I proceed to ſhew the Meaſure of the ſeveral Sizes, and in ſeveral reſpective Places, which I preſume will give exact and nice Proportions both for the Materials, and alſo for the Workman's Labour.

Size.	Tun.	Magnitude of the Ship.	Feet.	Inch	Superficies of the Ship from the Keel to the Top-timber Head on both ſides.	Feet.	Inch.	Length of the Circle between the lower Wale and the Keel, as a Plank generally lies.
Firſt	1700		19782	0		171	0	
Second	1400		17144	0		166	0	
Third	1000		11936	0		150	0	
Fourth	600		9190	0		129	0	
Fifth	350		6266	0		105	0	
Sixth	250		4396	0		50	0	

Size.	Tun.	Magnitude of the Ship.	Numb.	The Number of Seams to the Wale under Water.	Feet.	Inch.	The Thickneſs of the Plank under Water.	Numb.	Number of the Seams above the Wale.	Inch.	Number of Decks to Calk computing ½ Decks to the Main Length.
Firſt	1700		27		0	4½		24		3½	
Second	1400		24		0	4		21		3¼	
Third	1000		23		0	3¾		15		2¾	
Fourth	600		22		0	3		15		2½	
Fifth	350		17		0	2¾		14		2¼	
Sixth	250		16		0	2¼		12		2	

Size.

Size.	*Tun.* Magnitude of the Ship.	*Feet.* The Breadth of each Ship's.	*Inch.*	*Feet* Length of the Ship according to the ſhearing Line, between the upper Wale and the Top-timber Head.	*Feet.* Superficies from the Keel to the upper Edge of the upper Wale ranging with the Sheer.
First	1700	48	0	184	10950
Second	1400	45	0	176	9752
Third	1000	40	0	158	7512
Fourth	600	34	0	138	5402
Fifth	350	29	0	112	3802
Sixth	250	24	6	96	2668

Size.	*Tun.* Magnitude of the Ship.	*Feet.* Superficies from the upper Edge of the upper Wale to the Top-timber Head.	*Feet.* Height of the Side, according to the tumbling Home from the Wale to the Top-timber Head, near the Waſte or next Drift Abaft the Waſte.
First	1700	8832	24
Second	1400	7392	21
Third	1000	4424	14
Fourth	600	3788	13
Fifth	350	2464	11
Sixth	250	1728	9

The Superficies are one to another under the Wale.	Firſt Size to the ſecond is as 9 to 8	Above the Wale the Superficies are one to another as	6 to 5
	Firſt Size to the third is as 13 to 9		2 to 1
	Firſt Size to the fourth is as 2 to 1		7 to 3
	Firſt Size to the fifth is as 20 to 7		11 to 3
	Firſt Size to the ſixth is as 25 to 6		26 to 5

These Tables ſhew you the Superficial Content in each, from the Keel to the Wale without Board; alſo the Superficial Content from the Wale to the Top-timber Head, the ſame ſide with the Superficial Content of both. There is alſo the various Thickneſs of the Plank under Water, with what Number of Decks each Ship may be allowed of the extream Length of the lower Deck.

The Breadth of each Ship is alſo ſet down, with the Height on the Girt or Circumference of the Body, both from the Wale to the Keel, and alſo from the Wale to the Top-timber Head, from which I ſhall proceed to ſhew the Proportion one Ship's Parts has to another.

The Thickneſs of their Plank is one to another as	Firſt Size to the ſecond is as 9 to 8	The whole Superficial Contents are one to another as	7 to 6
	Firſt Size to the third is as 9 to 7		5 to 3
	Firſt Size to the fourth is as 9 to 6		15 to 7
	Firſt Size to the fifth is as 18 to 11		16 to 5
	Firſt Size to the ſixth is as 2 to 1		23 to 5

The Number of Seams from the Keel to the Top-timber Head, allowing for the Work between the Wales and the double Wale, counted of one Side of the Ship.	Firſt Size is	56
	Second Size is	50
	Third Size is	40
	Fourth Size is	39
	Fifth Size is	33
	Sixth Size is	30

Then the Proportion of theſe Numbers of Seams will be to one another as	Firſt to ſecond	10 to 9
	Firſt to third	7 to 5
	Firſt to fourth	10 to 7
	Firſt to fifth	17 to 10
	Firſt to ſixth	13 to 7

I am really of Opinion, although the common Cuſtom is otherwiſe, that all the Plank without Board may be ſized according to theſe Proportions; and if it is not thought proper to reduce or augment the great Ship's Plank to the ſmall Size, or otherwiſe the ſmall Ship's Plank to the large Size, there may be a Congreſs in the Sizes, lifting ſome and lowering others, until it is moſt properly brought to a general Proportional Head, for the Conveniency of Calking, which will be the greateſt Objection that can be ſtarted on this Particular, for as to the Strength requiſite it may be made up with the Covering within Side.

And this Obſervation well executed will make ſuch Calculations much eaſier, than when there is ſuch a Mixture of Sizes as is now in common Practice. But to proceed,

If you add the Medium Length of the Ship under the Wale and above the Wale together, the Sums will ſtand thus,

	Feet.
Firſt Size is	355
Second Size is	342
Third Size is	308
Fourth Size is	287
Fifth Size is	217
Sixth Size is	186

Then the Proportion of theſe Lengths will be one to another.

Firſt to ſecond will be as	31	to	30
Firſt to third will be as	8	to	7
Firſt to fourth will be as	5	to	4
Firſt to fifth will be as	13	to	8
Firſt to ſixth will be as	15	to	8

And now there will be three Fractions compounded with the Length of the Ship, Number of Seams and Thickneſs of the Plank, to find a Proportion or Value that one Ship's Calking has to the other, which Compound Fractions will be then as follows.

The firſt Size to the ſecond is as	9	to	8	This is the Proportion the Thickneſs of the Plank has to each other.
The firſt Size to the third is as	9	to	7	
The firſt Size to the fourth is as	9	to	6	
The firſt Size to the fifth is as	18	to	11	
The firſt Size to the ſixth is as	2	to	1	

The firſt Size to the ſecond is as	10	to	9	This is the Proportion the Number of Seams has to each other.
The firſt Size to the third is as	7	to	5	
The firſt Size to the fourth is as	10	to	7	
The firſt Size to the fifth is as	17	to	10	
The firſt Size to the ſixth is as	13	to	7	

The firſt Size to the ſecond is as	31	to	30	This is the Proportion that the Medium Lengths have to each other.
The firſt Size to the third is as	8	to	7	
The firſt Size to the fourth is as	5	to	4	
The firſt Size to the fifth is as	13	to	8	
The firſt Size to the ſixth is as	15	to	8	

And then the Fractions will ſtand thus, *viz.*

For the firſt to ſecond, The $\frac{8}{9}$ of $\frac{9}{10}$ of $\frac{30}{31}$, which multiply'd is

8		10		
9		9		
72		90		
30		31		
2160	Numerator.	2790	Denominator.	Fraction is $\frac{2160}{2790}$.

The Fraction reduced in its leaſt Terms, for the Proportion of the Parts, from a firſt Size to a ſecond is $\frac{7}{9}$.

For the firſt to the third. The $\frac{5}{9}$ of the $\frac{7}{7}$ of the $\frac{7}{8}$, which multiply'd is

$$\begin{array}{r} 5 \\ 7 \\ \hline 35 \\ 7 \\ \hline 245 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 9 \\ 7 \\ \hline 63 \\ 8 \\ \hline 504 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{245}{504}$.

The Fraction reduc'd into its leaſt Terms, for the Proportion of the Parts, of the firſt Size to the third is $\frac{14}{29}$.

For the firſt to the fourth. The $\frac{6}{9}$ of the $\frac{7}{10}$ of the $\frac{4}{5}$, which multiply'd is

$$\begin{array}{r} 6 \\ 7 \\ \hline 42 \\ 4 \\ \hline 168 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 9 \\ 10 \\ \hline 90 \\ 5 \\ \hline 450 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{168}{450}$.

The Fraction reduc'd into its leaſt Terms, for the Proportion of the Parts, of the firſt Size to the fourth is near $\frac{3}{8}$.

For the firſt to the fifth. The $\frac{11}{18}$ of the $\frac{10}{17}$ of the $\frac{8}{13}$, which multiply'd is

$$\begin{array}{r} 11 \\ 10 \\ \hline 110 \\ 8 \\ \hline 880 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 18 \\ 17 \\ \hline 126 \\ 18 \\ \hline 306 \\ 13 \\ \hline 918 \\ 306 \\ \hline 3978 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{880}{3978}$.

The Fraction reduc'd into its leaſt Terms, for the Proportion of the Parts, of the firſt Size to the fifth is near $\frac{6}{29}$.

For the firſt to the ſixth. The $\frac{1}{2}$ of the $\frac{7}{13}$ of the $\frac{8}{15}$, which multiply'd is

$$\begin{array}{ll} 7 & 13 \\ 8 & 2 \\ \hline 56 \text{ Numerator.} & 26 \\ & 15 \\ \hline & 130 \\ & 26 \\ \hline & 390 \text{ Denominator.} \end{array}$$

The Fraction is $\frac{56}{390}$.

The Fraction reduced into its leaſt Terms, for the Proportion of the Parts, that the firſt Size has to the ſixth is near $\frac{1}{7}$.

From which it appears, that the Proportion of Calking the Seams of each ſized Ship, from the Keel to the Top-timber Head, will be directly Proportionable to theſe Fractions, which will be as follows.

The firſt Size to the ſecond is as — — — 9 to 7
The firſt Size to the third is as — — — 29 to 14
The firſt Size to the fourth is as — — — 8 to 3
The firſt Size to the fifth is as — — — 29 to 6
The firſt Size to the ſixth is as — — — 7 to 1

But the Squaring, which is meant of Calking Rents (or ſmall Crannies) and the Trenels may in all likelyhood be as much in a ſmall Ship as a great Ship, according as their Superficies are one to another, ſince the Trenels will be more in the ſmall Ship than in the great; but the Rents and Shans (as they are term'd) will require to be better, or ſtronger forc'd in thick Plank than in thin Plank, according to its various Thickneſs; beſides, there may be a vaſt Difference in the Value of Calking, cauſed through the Goodneſs and Badneſs of the Plank, more in one Ship than in another, and alſo by the well joyning of the Planks Edges; but that being a Matter which will be ſo very promiſcuous, it muſt be referred to the Sight and Experience of the Calker, or experienc'd Artificer; and I will proceed to ſhew the Value of Calking and Squaring the Rents and Trenels, and that will be found from that Proportion the Superficies (from the Keel to the Top-timber Head) has one to the other, which is,

The Proportion of the Superficial Content from the Keel to the Top-timber Head is
The firſt to the ſecond is as — — 7 to 6
The firſt to the third is as — — 5 to 3
The firſt to the fourth is as — 15 to 7
The firſt to the fifth is as — — 16 to 7
The firſt to the ſixth is as — — 23 to 5

I ſhall proceed in the next Place to calculate the Superficial Content in each Deck, of the ſeveral ſized Ships, allowing that the Thickneſs of the Plank in the Decks ſhall be in the ſame Proportion with the Thickneſs of the Plank in the Bottom.

		Feet.	In.
Plank of 4 Inches.	The firſt ſized Ships Lower Deck will be 44 Feet Broad, 170 Ft. long, having 45 Seams, containing	6736	$4\frac{1}{2}$
Deals.	Ditto. Middle Deck will be 41 Ft. Broad, 171$\frac{1}{2}$ Ft. long, having 42 Seams, containing	6226	$3\frac{1}{2}$
	Ditto. Upper Deck will be 36 Ft. Broad, 173 Ft. long, having 36 Seams, containing	5340	$3\frac{1}{3}$
	For Quarter Deck, Forecaſtle, and Poop Decks, I allow $\frac{3}{4}$ of the Upper Deck, which will then contain	4036	3
	The Total Sum contain'd in the Decks is ——	22339	$2\frac{1}{2}$
	For Spirkitriſing and Quick-work ——	3440	0
	The Total Content ——	25779	$2\frac{1}{2}$

There will be very probably in all this Superficial Content, 173 Seams of the whole Length of the Lower Deck; but that Matter I allow to be various, according to the Breadth of each Plank; however, I fix this at 173.

		Feet.	In.
Plank of 4 Inches.	Second Sizes Lower Deck will be 41 Ft. Broad, 165 Ft. long, having 42 Seams, containing	6137	4
Deals.	Ditto. Middle Deck will be 38 Ft. Broad, Length 166 Ft. $\frac{1}{2}$, having 39 Seams, containing	5630	$3\frac{1}{10}$
	Ditto. Upper Deck will be 33 Ft. Broad, Length 168 Ft. having 34 Seams, containing	4800	$3\frac{1}{10}$
	Half of ſuch a Deck will be for the Quarter, and Fore-caſtle, and Poop Deck, containing	2400	$1\frac{11}{20}$
	The Total Sum contained in the Decks is ——	18967	$11\frac{3}{4}$
	For Spirkit-riſing and Quick-work the Superficies will be —	2970	0
	The Total Content will be —— ——	21937	$11\frac{3}{4}$

There will be very probably in all this Superficial Content 152 Seams of the whole Length of the Lower Deck, and with the ſame Caution as aforeſaid.

		Feet.	In.
Plank of $3\frac{1}{2}$ Inches.	Third Sizes Lower Deck will be 36 Ft. $\frac{1}{2}$ Broad, Length 150, having 39 Seams, containing	4911	$3\frac{1}{2}$
Deal $2\frac{1}{2}$	Ditto. Upper Deck will be 32 Ft. $\frac{5}{10}$ Broad, Length 151 $\frac{1}{2}$, having 35 Seams, containing	3311	$2\frac{4}{10}$
2	The $\frac{3}{4}$ of ſuch a Deck will be for the Quarter, and Forecaſtle, and Poop Deck, containing	2510	$1\frac{2}{10}$
	The Total Sum contain'd in the Decks is ——	10732	$7\frac{1}{10}$
	For Spirkit-riſing and Quick-work the Superficies is ——	2250	0
	The Total Content will be ——	12982	$7\frac{1}{10}$

There will be very probably in all this Superficial Content, 117 Seams of the whole Length of the Lower Deck, obſerving the former Caution.

		Feet.	In.
Plank of 3. Inches.	Fourth Sizes Lower Deck will be 32 Ft. Broad, Length 130 Ft. having 33 Seams, containing	3608	0
Deal $1\frac{1}{2}$	Ditto. Upper Deck will be 28 Ft. $\frac{1}{2}$ Broad, Length 131 $\frac{1}{4}$ having 33 Seams, containing	2459	0
2	The $\frac{5}{8}$ of the Upper Deck will be for the Quarter Deck, and Forecaſtle, and Poop Deck, containing	1546	0
	The Total Sum contain'd in the Decks will be ——	7613	0
	For Spirkit-riſing and Quick-work the Superficies will be —	1820	0
	The Total Content will be ——	9433	0

There will be very probably in all this Superficial Content, 108 Seams of the whole Length of the Lower Deck, obſerving the former Caution.

		Feet.	In.
Plank or Deal $2\frac{6}{10}$	Fifth Sizes Lower Deck will be 28 Ft. Broad, Length 106, having 33 Seams, containing	2584	0
Deal	Ditto. Upper Deck will be 24 Ft. $\frac{1}{2}$ Broad, Length 107 $\frac{1}{13}$, having 31 Seams, containing	1740	0
	Half ſuch an Upper Deck will be for the Quarter and Forecaſtle Deck, containing	0870	0
	The Total Sum contain'd in the Deck will be —	5194	0
	For Spirkit-riſing and Quick-work the Superficies will be —	1378	0
	The Total Content will be ——	6572	0

There will be very probably in all this Superficial Content 96 Seams and $\frac{1}{2}$ of the whole Length of the Lower Deck, obſerving the former Caution.

		Feet.	In.
Deal $2\frac{1}{4}$	Sixth Sizes Lower Deck will be 23 Ft. Broad, Length 96 Ft. having 30 Seams, containing	1864	0
Ditto $1\frac{1}{2}$	Ditto. Upper Deck will be 19 Ft. Broad, Length 97 Ft. having 25 Seams, containing	1278	0
	The Total Sum contained in the Deck will be ——	3142	0
	For Spirkit-riſing and Quick-work the Superficies will be ——	576	0
	The Total Content will be —— ——	3718	0

There will be very probably in all this Superficial Content, 63 Seams of the whole Length of the Lower Deck, obſerving the former Caution.

	Feet.	In.
Then the Total Content of all the Decks Spirkit-riſing and Quick-work in the firſt Size will be	25779	$2\frac{1}{5}$
The Total Content on the Superficies of all the Decks Spirkit-riſing and Quick-work in the ſecond Size Ship will be	21937	$11\frac{3}{4}$
The Total Content on the Superficies of all the Decks Spirkit-riſing and Quick-work in the third Size Ship will be	12982	$7\frac{1}{10}$
The Total Content on the Superficies of all the Decks Spirkit-riſing and Quick-work in the fourth Size Ship will be	9433	0
The Total Area of all the Decks Spirkit-riſing and Quick-work on the Superficies in the fifth Size Ship will be	6572	0
The Total Area of all the Decks Spirkitriſing, and Quick-work on the Superficies in the fifth ſized Ship will be	3718	0

Then the Proportions will be one to another as follows.

The firſt Size to the ſecond will be as	13 to 11
The firſt Size to the third will be as	2 to 1
The firſt Size to the fourth will be as	11 to 4
The firſt Size to the fifth will be as	14 to 1
The firſt Size to the ſixth will be as	7 to 1

Obſerving that the Tunnage in each has reference to what has paſſed, ſo that the Magnitudes will ſtand thus.	Firſt Size is	1700	Tuns.
	Second Size is	1400	
	Third Size is	1000	
	Fourth Size is	600	
	Fifth Size is	350	
	Sixth Size is	250	

The Number of Seams in each are as follows.	Firſt Size is	173	Seams.
	Second Size is	152	
	Third Size is	117	
	Fourth Size is	108	
	Fifth Size is	96½	
	Sixth Size is	62	

Then the Proportion of the Seams will be one to another as follows.	Firſt Size to the ſecond is as	8 to 7
	Firſt Size to the third is as	3 to 2
	Firſt Size to the fourth is as	8 to 5
	Firſt Size to the fifth is as	9 to 5
	Firſt Size to the ſixth is as	11 to 4

		Feet.
The Length of the Lower Gun-Deck is, which will be ſufficient to gain a Proportion.	Firſt Size is	170
	Second Size is	165
	Third Size is	150
	Fourth Size is	130
	Fifth Size is	106
	Sixth Size is	96

Then the Proportion of the Length will be one to another as follows.	Firſt Size to the ſecond is as	34 to 33
	Firſt Size to the third is as	8 to 7
	Firſt Size to the fourth is as	17 to 13
	Firſt Size to the fifth is as	11 to 7
	Firſt Size to the ſixth is as	16 to 9

I could never obſerve in all the Experience I have had in Ship-building, that the Men of this Calking above all others (which in the leaſt caſe related to the Miſtery of Ship-building) matter'd a ſmall Portion of Work; but could comply with Time and Variety, tho' their Share or Births was ever ſo unequal, and therefore altho' I have been ſomewhat nice in my Calculations, I might have ſaved ſome Labour in ſuch a Curioſity: And ſo I proceed to ſhew the Value of Calking and Squaring the Work within-board, as Deck, and the like; and in doing of it I ſhall take the aforeſaid Method for the Seams, making Uſe of the Compound Fractions, obtain'd by the Length of the Lower Deck and Number of Seams, which are as follows.

The firſt to the ſecond is, The $\frac{7}{8}$ of the $\frac{33}{34}$, which multiply'd is

$$\begin{array}{r} 33 \\ 7 \\ \hline 231 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 34 \\ 8 \\ \hline 272 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{231}{272}$.

The Fraction reduced into its leaſt Terms, for a firſt Size to a ſecond is $\frac{11}{13}$.

The firſt to the third is, The $\frac{2}{3}$ of the $\frac{7}{8}$, which multiply'd is

$$\begin{array}{r} 7 \\ 2 \\ \hline 14 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 8 \\ 3 \\ \hline 24 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{14}{24}$.

The Fraction reduced into its leaſt Terms, for a firſt Size to a third is $\frac{7}{12}$.

The firſt to the fourth is, The $\frac{5}{8}$ of the $\frac{13}{17}$, which multiply'd is

$$\begin{array}{r} 13 \\ 5 \\ \hline 65 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 17 \\ 8 \\ \hline 136 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{65}{136}$.

The Fraction reduced into its leaſt Terms, for a firſt Size to a fourth is $\frac{10}{21}$.

The firſt to the fifth is, The $\frac{5}{9}$ of the $\frac{7}{11}$, which multiply'd is

$$\begin{array}{r} 7 \\ 5 \\ \hline 35 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 11 \\ 9 \\ \hline 99 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{35}{99}$.

The Fraction reduced into its leaſt Terms, for a firſt Size to a fifth is $\frac{6}{17}$.

The firſt to the ſixth is, The $\frac{4}{11}$, of $\frac{9}{16}$, which multiply'd is

$$\begin{array}{r} 9 \\ 4 \\ \hline 36 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 16 \\ 11 \\ \hline 16 \\ 16 \\ \hline 176 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{36}{176}$.

The Fraction reduced into its leaſt Terms, for a firſt Size to a ſixth is $\frac{1}{5}$.

From which it appears, that Calking the Seams of the Decks, Spirkit-riſing, and Quick-work in theſe ſix ſiz'd Ships, will bear the following Proportion.

The firſt Size to the ſecond is as —— —— —— 13 to 11
The firſt Size to the third is as —— —— —— 12 to 7
The firſt Size to the fourth is as —— —— —— 21 to 10
The firſt Size to the fifth is as —— —— —— 17 to 6
The firſt Size to the ſixth is as —— —— —— 5 to 1

As to the Squaring or finiſhing the Calking Work of theſe Decks, Spirkit-riſing, and Quick-work, the Proportion will be as the Superficies are one to another.

Then the Proportion of the Superficies of the whole Ship, from the Keel to the Top-timber Head, will be the Rule for Calking the Rents and Trenels, which are as follows.

The firſt Size to the ſecond is as 7 to 6
The firſt Size to the third is as 5 to 3
The firſt Size to the fourth is as 15 to 7
The firſt Size to the fifth is as 16 to 5
The firſt Size to the ſixth is as 23 to 5

And ſo the Superficies of the whole Ships bear in Proportion one to another.

The Areas of the Work that is Calked within Board, to that which is without Board, is as follows:

Areas of
- The firſt Size Ship's Work within, to the Work without-ſide is as 17 to 13.
- The ſecond ſize Ship's Work within, to the Work without-ſide, is as 9 to 7.
- The third ſize Ship's Work within, to the Work without-ſide, is as 13 to 12.
- The fourth ſize Ship's Work within, to the Work without-ſide, is as 29 to 28.
- The fifth ſize Ship's Work within, to the Work without-ſide. is as 22 to 21.
- The ſixth ſize Ship's Work within, to the Work without-ſide, is as 6 to 5.

And from theſe Calculations it appears, that the Superficial Area to be Calked on Board of any Ship is more on the inſide than on the outſide, however I ſhall give two Reaſons (though ſeemingly oppoſite one to another) how this Matter may be made very near equal.

And firſt the Labour is much greater in Calking the Work without Board, to what it is in Calking the Work within Board, eſpecially the Bottom of any Ship, where the labouring Man is in divers Caſes under his Work, and will require more Strength to force his Oakham, and lay the Seams open, than if he was on the Decks and over his Work: But then if all Hatch-ways, Bulk-heads, Planſheers, Timber-heads, Gunnels, and Baſements be counted to the inſide Work, which I count reaſonable that they ſhould, ſince it's the laſt Side finiſhed; then indeed ſuch piddling Work will require Time equal with the hard Labour, cauſed by the Workman being under his Work.

And the Size of the Plank will be near equal, ſince the Decks will correſpond to the Plank without Board, and the Spirkit-riſing equal to the thick Strakes near, and about the lower Wales, and by Conſequence the Calking any Ship within Board, will be in every reſpect equal to the Calking any Ship without Board, or at furtheſt as the preceeding are one to another, either Direct or Reverſe.

I ſhall proceed now to ſhow a Proportion for Calking any Ship from her different Magnitude, it being found by Experience, that a Ship of 100 Tuns can be Calked for 2 *s.* per Tun, and a Ship of 600 Tuns, for 2 *s.* 6 *d.* per Tun: So that there is but 6 *d.* Difference in 500 Tuns Advance in the Bulk of the Ship, and therefore it muſt be allowed, that the Difference in the Work between great Ships and ſmall ones, will be made up by the Difference there is in the Tunnage, as well in the ſuperficial Area, as in the Thickneſs of the Plank.

The Tunnage is in the ſeveral Sizes.	Firſt Size	1700	Tuns.
	Second Size	1400	
	Third Size	1000	
	Fourth Size	600	
	Fifth Size	350	
	Sixth Size	250	

Then the Proportion of the Tunnage will be	The firſt Size to the ſecond is as	7 to 6
	The firſt Size to the third is as	17 to 10
	The firſt Size to the fourth is as	23 to 9
	The firſt Size to the fifth is as	23 to 5
	The firſt Size to the ſixth is as	13 to 2

The whole Superficies of thoſe Ships will be	Firſt Size	45520	Feet.
	Second Size	39081	
	Third Size	24918	
	Fourth Size	18623	
	Fifth Size	12838	
	Sixth Size	8114	

Then the Proportion of their Superficies will be one to another as	The firſt Size to the ſecond is as	7 to 6
	The firſt Size to the third is as	11 to 6
	The firſt Size to the fourth is as	17 to 7
	The firſt Size to the fifth is as	7 to 2
	The firſt Size to the ſixth is as	17 to 3

The Proportion of the Planks Thickneſs will be as follows	9 to 8
	9 to 7
	9 to 6
	18 to 11
	2 to 1

Then there will be the Superficies and different Thickneſs in the Plank to be conſider'd againſt the different Tunnage and Price, or more plainly ſpeaking, the different Proportion between the Tunnage of ſmall and great Ships, and the Price allowed for Calking them, ſhall be equal to the Superficies and the Thickneſs of the Plank as follows, there being a Compound Fraction to be made out of the Superficies and Thickneſs of the Plank.

$$\begin{array}{cc} 8 & 9 \\ 6 & 7 \\ \hline \end{array}$$

The firſt to ſecond. The $\frac{8}{9}$ of $\frac{6}{7}$ × is 48 Numerator. 63 Denominator, the Fraction is $\frac{48}{63}$, which reduc'd in its leaſt Terms is $\frac{10}{13}$.

$$\begin{array}{cc} 6 & 11 \\ 7 & 9 \\ \hline \end{array}$$

Firſt to third. The $\frac{7}{9}$ of the $\frac{6}{11}$ is × 42 Numerator. 99 Denominator, the Fraction is $\frac{42}{99}$, which reduc'd in its leaſt Terms is $\frac{2}{7}$.

First

$$\begin{array}{rr} 6 & 17 \\ 7 & 9 \\ \hline \end{array}$$

First to fourth. The $\frac{6}{9}$ of the $\frac{7}{17}$ is × 42 Numerator. 153 Denominator, the Fraction is $\frac{42}{153}$, which reduc'd to its leaſt Terms is $\frac{7}{26}$.

$$\begin{array}{rr} 11 & 18 \\ 2 & 7 \\ \hline \end{array}$$

First to fifth. The $\frac{11}{18}$ of the $\frac{2}{7}$ is × 22 Numerator. 126 Denominator, the Fraction is $\frac{22}{126}$, which reduc'd to its leaſt Terms is $\frac{4}{23}$.

$$\begin{array}{rr} 3 & 17 \\ 1 & 2 \\ \hline \end{array}$$

First to ſixth. The $\frac{1}{2}$ of the $\frac{3}{17}$ is × 3 Numerator. 34 Denominator, the Fraction is $\frac{3}{34}$, which reduc'd to its leaſt Terms is $\frac{3}{34}$.

So that the Proportion of the different Value of Calking will ſtand thus,

The firſt Size to the ſecond is as	13	to	20
The firſt Size to the third is as	7	to	3
The firſt Size to the fourth is as	26	to	7
The firſt Size to the fifth is as	23	to	4
The firſt Size to the ſixth is as	34	to	3

And the different Tunnage and Price muſt make a Fraction equal to this Proportion.

Which Proportion for the Money per Tun to Calk the ſeveral Sizes will be

Firſt to ſecond as —	9	to	8
Firſt to third as —	6	to	4½
Firſt to fourth as —	7	to	5
Firſt to fifth as —	5	to	3
Firſt to ſixth as —	17	to	1

Then if a Ship of 600 Tuns (which is a fourth ſized Ship) be Calked for 2 *s.* 6 *d.* per Tun, what ſhall the other Ships be Calked for per Tun? The Proportion will be thus,

					d.		*d.*
Say, as	5	is to	7,	ſo is	30	to	42
	9	is to	8,	ſo is	42	to	37½
	6	is to	4½,	ſo is	42	to	31½
	5	is to	4,	ſo is	42	to	33½
	17	is to	1,	ſo is	42	to	25

And then the Value of Calking the ſeveral Sizes *per* Tun will be as follows,

	l.	*s.*	*d.*
The firſt ſized Ship's Calking per Tun will be — —	0	3	6
The ſecond ſized Ship's Calking per Tun will be — —	0	3	1½
The third ſized Ship's Calking per Tun will be — —	0	2	7½
The fourth ſized Ship's Calking per Tun will be — —	0	2	6
The fifth ſized Ship's Calking per Tun will be — —	0	2	6
The ſixth ſized Ship's Calking per Tun will be — —	0	2	1

And from all which it will appear that the different Value per Tun, which will be in Calking any three Deck Ship, is but Four Pence Half-penny, and the different Value per Tun, which will be in Calking any two Deck Ships is but Three Pence, and in all one Deck Ships the different Value will not be above

Two

Two Pence, and if Ships Tunnage was nicely adjuſted by ſuch a Method as I have deſcribed in my Ship-builder's Aſſiſtant, I am really of Opinion, the Difference will ariſe in Calking, only by the different Number of Decks more in one Ship than there is in another Ship. And ſo I proceed to ſhew the Value of Calking any Ship by the Number of Feet contain'd in her Seams, and alſo the Size of the Plank, only firſt I will make a Calculation of the Breadth of every Plank, which will be agreeable to the Thickneſs.

And the Method I ſhall take for making ſuch a Calculation ſhall be thus; Having experienc'd the Breadths that are generally made uſe of in covering Ship's with Plank or thick Stuff, only minding that Wale-Pieces, and ſuch Work as has exact Gauges aſſigned, are not to come under this Calculation.

The Thickneſs of the Planks which are generally made Uſe of is, from 1 Inch and a half thick to 10 Inches thick. I therefore find the ſquare Root of every Plank's Thickneſs, and multiply that Number by 7 or 8, allowing that 7 Diameters of the Thickneſs ſhall be a ſizeable Breadth in the leaſt Terms, and 8 Diameters of the Thickneſs ſhall be a ſizeable Breadth in the greateſt Terms, a Medium of which will produce the Breadth of Plank agreeable to every reſpective Thickneſs as follows.

Inches. The Thickneſs of the Plank in Inches and Parts.	Square Root of each reſpective Thickneſs.	*Inches.* Seven times the Square Root, or ſeven Diameters of the Thickneſs of the Plank's ſquare Root, which is the Breadth of the Strakes of Plank in the leaſt Terms.	*Inches.* Eight times the ſquare Root, which gives the Breadth of the Strakes of Plank in the greateſt Terms.
1	1	7	8
1 $\frac{1}{2}$	1 $\frac{22}{100}$	8 $\frac{1}{2}$	9 $\frac{3}{4}$
2	1 $\frac{41}{100}$	9 $\frac{9}{10}$	11 $\frac{1}{4}$
3	1 $\frac{73}{100}$	12	13 $\frac{3}{4}$
4	2	14	16
5	2 $\frac{24}{100}$	15 $\frac{1}{4}$	18
6	2 $\frac{45}{100}$	17 $\frac{1}{10}$	19 $\frac{1}{2}$
7	2 $\frac{65}{100}$	18 $\frac{1}{2}$	21 $\frac{1}{4}$
8	2 $\frac{83}{100}$	19 $\frac{3}{4}$	22 $\frac{1}{2}$
9	3	21	24
10	3 $\frac{15}{100}$	22	25

And this Rule will be a very exact Strike for ſizeing the Breadth of the Planks to their reſpective Thickneſs, either on a Ship's Side without Board, or for the Work within Board, and alſo for the Decks, and ſo I proceed to ſhew the Value of Calking, according to the Feet of Seams calked.

It being obſerved, that on a new Ship's Side a Calker can calk and ſquare the Work in the Wake of 48 Foot of Seam, and on Plank of 4 Inches thick, and all this has been complied with in one Day, or for 4 *s.* which in my Opinion, if he doth it well, he moſt certainly deſerves the Money mention'd; but to proportion the other Thickneſs of Plank from 4 Inches, will require divers Conſiderations, as well as many Calculations.

As firſt the Area, ſince the Squaring will be very near equal in the Plank, tho' ever ſo various in its Thickneſs, or rather more in thin Plank than in thick, according as the Magnitudes of the Ships are one to another.

But as to the Value of Calking the Seams, they muſt in all likelihood be according as the Thickneſs of the Planks are one to another, provided there be a nice Method uſed for filling the Seam with Oakham, and that the Shipwright's Work be equally well or ill wrought, and alſo that the Conveniency be agreeable in every reſpect for the Workman to perform his Labour.

The Proportion of the Plank is one to another as

10 to 9
10 to 8
10 to 7
10 to 6
10 to 5
10 to 4
10 to 3
10 to 1½
10 to 1

The Superficies in 48 Foot of Seam in the ſeveral thickneſs of Plank, according to my preceeding Allowance for the Breadth of Plank, will be in

Inch		Feet.
10		88
9		84
8		78
7		73
6	Plank,	63
5	it will	63
4	be	56
3		48
2		39
1½		34
1		28

Then the Proportion of the Superficies in the ſeveral thickneſs of Plank and thick Stuff, will be in ~~the~~

Inch. Inch	It will be as
10 to 9	21 to 20
10 to 8	9 to 8
10 to 7	12 to 10
10 to 6	9 to 7
10 to 5	7 to 5
10 to 4	11 to 7
10 to 3	11 to 6
10 to 2	9 to 4
10 to 1½	13 to 5
10 to 1	22 to 7

Then there will be a Compound Fraction made with the Thickneſs of the Plank one to another, and the ſuperficial Area in 48 Foot of Seam to gain a Proportion for the Price per Foot in each Particular.

$$\begin{array}{cc} 20 & 21 \\ 9 & 10 \\ \hline \end{array}$$

For the firſt Size it is $\frac{9}{10}$ of $\frac{20}{21}$, which × is 180 Numerator, 210 Denominator, the Fraction is $\frac{180}{210}$, reduc'd is $\frac{6}{7}$.

$$\begin{array}{cc} 8 & 10 \\ 8 & 9 \\ \hline \end{array}$$

For the ſecond Size it is $\frac{8}{10}$ of $\frac{8}{9}$, which × is 64 Numerator, 90 Denominator, the Fraction is $\frac{64}{90}$, reduc'd is $\frac{12}{17}$.

$$\begin{array}{cc} 10 & 12 \\ 7 & 10 \\ \hline \end{array}$$

For the third Size it is $\frac{7}{10}$ of $\frac{10}{12}$, which × is 70 Numerator, 120 Denominator, the Fraction is $\frac{70}{120}$, reduc'd is $\frac{7}{12}$.

$$\begin{array}{cc} 7 & 10 \\ 6 & 9 \\ \hline \end{array}$$

For the fourth Size it is $\frac{6}{10}$ of $\frac{7}{9}$, which × is 42 Numerator, 90 Denominator, the Fraction is $\frac{42}{90}$, reduc'd is $\frac{7}{15}$.

$$\begin{array}{cc} 5 & 10 \\ 5 & 7 \\ \hline \end{array}$$

For the fifth Size it is $\frac{5}{10}$ of $\frac{5}{7}$, which × is 25 Numerator, 70 Denominator, the Fraction is $\frac{25}{70}$, reduc'd is $\frac{5}{14}$.

$$\begin{array}{cc} 7 & 11 \\ 4 & 10 \\ \hline \end{array}$$

For the ſixth Size it is $\frac{4}{10}$ of $\frac{7}{11}$, which × is 28 Numerator, 110 Denominator, the Fraction is $\frac{28}{110}$, reduc'd is $\frac{12}{47}$.

For

6	11
3	10

For the ſeventh Size it is $\frac{3}{10}$ of $\frac{6}{11}$, which × is 18 Numerator, 110 Denominator, the Fraction is $\frac{18}{110}$, reduc'd is $\frac{6}{135}$.

4	10
2	9

For the eighth Size it is $\frac{2}{10}$ of $\frac{4}{9}$, which × is 8 Numerator, 90 Denominator, the Fraction is $\frac{8}{90}$, reduc'd is $\frac{4}{45}$.

5	20
3	13

For the ninth Size it is $\frac{5}{20}$ of $\frac{3}{13}$, which × is 15 Numerator, 260 Denominator, the Fraction is $\frac{15}{260}$, reduc'd is $\frac{15}{260}$.

7	22
1	10

For the tenth Size it is $\frac{1}{10}$ of $\frac{7}{22}$, which × is 7 Numerator, 220 Denominator, the Fraction is $\frac{7}{220}$, reduc'd is $\frac{7}{220}$.

Then the different Value in Calking of each Size will ſtand thus,

	Inch.		Inch.				
For	10	to	9	The Value will be as	7	to	6
	10	to	8		12	to	7
	10	to	7		12	to	7
	10	to	6		16	to	7
	10	to	5		14	to	5
	10	to	4		24	to	12
	10	to	3		13	to	6
	10	to	2		45	to	4
	10	to	1½		260	to	15
	10	to	1		220	to	7

Then ſay, if 48 Foot of 4 Inch Plank be worth 4 *s.* Calking, or 48 *d.* what ſhall the other Sizes be worth, or as 12 is to 47, ſo is the Proportion of 4 Inch Plank to 10 Inch Plank, including the Superficies as aforeſaid.

					Pence.		Pence.
If	12	be	47	what ſhall	48	give, it gives	180½
If	7	be	6	what ſhall	180½	give, it gives	150¾
If	171	be	12	what ſhall	180½	give, it gives	130
If	12	be	7	what ſhall	180½	give, it gives	107
If	15	be	7	what ſhall	180½	give, it gives	86
If	14	be	5	what ſhall	180½	give, it gives	66
If	37	be	6	what ſhall	180½	give, it gives	30
If	45	be	4	what ſhall	180½	give, it gives	16½
If	160	be	15	what ſhall	180½	give, it gives	10½
If	220	be	7	what ſhall	180½	give, it gives	6

Pence.		s.	d.		d.	Inches.	Feet.
180½	is	15	0½	Which is for every Foot	$2\frac{1}{10}$	10	23
150¼	is	12	6¼		$1\frac{9}{10}$	9	25½
130	is	10	10		$1\frac{1}{10}$	8	28½
107	is	8	11		$1\frac{1}{2}$	7	32
86	is	7	4		$1\frac{1}{4}$	6	38½
66	is	5	6		$1\frac{1}{100}$	5	46
48	is	4	0		$0\frac{81}{100}$	4	56½
30	is	2	6		$0\frac{62}{100}$	3	78
16½	is	1	4½		$0\frac{42}{100}$	2	115
10½	is	0	10½		$0\frac{21}{100}$	1½	156
6	is	0	6		$0\frac{21}{100}$	1	226

The Value of Calking and Squaring 1 Ft. of Seam on the Superficies of the ſeveral Sizes from 10 Inch. thick to 1 Inch thick, is from 2 Pence $\frac{1}{10}$ of a Peny to $\frac{21}{100}$ Parts of a Penny.

From this Calculation it appears, that a Calker ought to Square for one Day's Work of the ſeveral ſiz'd Plank as follows, at 4 *s. per* Day.

In this Calculation I allow a Calker to have 4 *s. per* Day, and the Tides to be porportion'd as aforeſaid. I ſhall only make uſe of one Caution, which is, that if it ſhall be approv'd reaſonable for the Weight of Oakham to be equal to the Vacuities of the Crannies, then the Value of Calking Plank of divers Species ought to be proportion'd from the Weight of Wood to be Calked, whether Oak, Elm, Beech, or Fir, which are to one another as follows.

Oak	870	This is the Proportion this Wood has to each other.
Elm	600	
Beech	854	
Fir	546	

And having gone through the Nature and Manner of Calking any Ship, with the Allowance both as to the Utenſils and Workman's Labour, I ſhall proceed now to the Paying and Covering the Ship with Pitch, Rozam, Tallow, and other Ingredients ſuitable for Mixtures, to perform either the Graving or Slubing (as Calkers term it) the Ship under Water, or above the Water's Edge, and alſo on the inſide of the Ship; but by the way I ſhall draw one Parallel between the Proportion of Calking a Ship in former Calculations, and what is done now, referring you to look backward on the Allowances that have been, and then in the Tables proceeding you may obſerve the Difference, with the Reaſonableneſs of the ſaid Alterations in ſuch an Allowance.

Firſt, in Graving a Ship under Water, you ought to be guided by the Superficies contained from the Keel to the Lower-wale; but however, ſince nothing can be a better Guide than Experience and Tryals, I ſhall at preſent be ruled by the Allowance formerly made in one particular Ship, and Proportion the reſt from that; in doing of which I ſhall allow it to be reaſonable for the ſmalleſt Ship to be the trueſt Guide, ſince it's the ſooneſt done, and in all likelyhood moſt exact.

And having made a Proportion of the Superficial Content from the Keel to the Upper-Wale, that will ſuffice to Proportion the Materials ſuitable for Graving, ſince I have deduc'd ſuch Proportions from one common Standard.

The Superficial Content or Area from the Keel to the Upper-wale	In the firſt Size of 1700 Tuns it is	10950
	In the ſecond Size of 1400 Tuns it is	9752
	In the third Size of 1000 Tuns it is	7512
	In the fourth Size of 600 Tuns it is	5402
	In the fifth Size of 350 Tuns it is	3802
	In the ſixth Size of 250 Tuns it is	2668

Then the Proportion one to another will be	Firſt Size to the ſecond is as	9 to 8
	Firſt Size to the third is as	13 to 9
	Firſt Size to the fourth is as	2 to 1
	Firſt Size to the fifth is as	20 to 7
	Firſt Size to the ſixth is as	25 to 6

The ancient Allowance for Rozam has been in this Proportion.	The firſt Size to the ſecond was as	7 to 6
	The firſt Size to the third was as	10 to 7
	The firſt Size to the fourth was as	18 to 8
	The firſt Size to the fifth was as	17 to 6
	The firſt Size to the ſixth was as	5 to 1

And now you may obſerve, that the Proportion of Rozam allowed by Cuſtom between a ſix Sized Ship and the firſt Size, is as 1 to 5; but the Superficial Area's are as 6 to 25. Now $\frac{1}{5}$ being equal to $\frac{6}{30}$, there appears $\frac{5}{30}$ Parts too much allowed the firſt Sized Ship in Proportion to that Allowance, which if found ſufficient to perform the Work in the ſixth ſized Ship, according to the various Area's contained in each Ship's Work, and by Conſequence all the reſt from the firſt downwards to the ſixth ſized Ship will be the ſame, according as their Magnitudes are one to another; from which I ſhall calculate a Proportion for the Rozam as follows, allowing that the Oyl, Brimſtone, and all other Materials for Graving, may be proportion'd from the Quantity of the Rozam, provided it be of equal Goodneſs, and managed with as much Judgment in a large Quantity as in a ſmall Quantity.

Sixth ſized Ship's Rozam as Cuſtom is 400 Weight.
The firſt ſized Ship's Superficies to the ſixth is as 26 to 6.
Then the firſt ſized Ship's Rozam will be 1700 ½ Weight.
The firſt ſized Ship's Superficies to the ſecond is as 9 to 8.
Then the ſecond ſized Ship's Rozam will be 1500 ½ Weight.
The firſt ſized Ship's Superficies to the third is as 13 to 9.
Then the third ſized Ship's Rozam will be 1200 Weight.
The firſt ſized Ship's Superficies to the fourth is as 2 to 1.
Then the fourth ſized Ship's Rozam will be 800 ½ Weight.
The firſt ſized Ship's Superficies to the fifth is as 20 to 7.
Then the fifth ſized Ship's Rozam will be 6 Hundred and 10 Pound.

	C.	q.	l.		Gallons.
Firſt ſized Rozam is ——	17	2	0	The Oyl from the Quantity of Rozam to make a true Mixture will be	43 ½
Second ſized Rozam is ——	15	2	0		38 ½
Third ſized Rozam is ——	12	0	0		30
Fourth ſized Rozam is ——	8	2	0		21 ¾
Fifth ſized Rozam is ——	6	0	10		15
Sixth ſized Rozam is ——	4	0	0		10

	C.	q.	l.			C.	q.	l.
The Brimſtone from the Quantity of Rozam, as aforeſaid, will be	7	2	0	The Black Pitch for Blacking will be from the Quantity of Rozam.	Firſt Size	7	2	0
	6	3	0		Second Size	6	3	0
	5	1	0		Third Size	5	1	0
	3	3	0		Fourth Size	3	3	0
	2	2	11		Fifth Size	2	2	11
——	0	3	0		Sixth Size	0	3	0

	Pounds		Pounds.		Pounds.
The Thrums from the ſame Proportion will be	30 ½	The Twine from the ſame Proportion will be	6 ½	The Leather from the ſame Proportion will be	6 ½
	27		5 ¾		5 ¾
	21		4 ½		4 ½
	15 ¼		3 ¼		3 ¼
	10 ¾		2 ¼		2 ¼
	8		0 ½		0 ½

		Sheaves.		Bavins.
The Proportion of the Sheaves of Reed will be from the ſame Porportion.	The firſt Size ——	3500	The Broom Bavins in lieu of Reed will be from the ſame Proportion.	2600
	The ſecond Size ——	3100		2300
	The third Size ——	2425		1800
	The fourth Size ——	1750		1300
	The fifth Size ——	1220		900
	The ſixth Size ——	800		600

	Dozen.		Number.		Number.
The ſweep-Brooms from the ſame Proportion will be	13	The Burning Poles from the ſame Proportion will be	26	The double Buckets from the ſame Proportion will be	13
	11 ½		23		12
	9		18		9
	6 ½		13		6
	4 ½		9		4
	3		6		3

And

And the Number of Men as Calkers to do the Labour agreeable to ſuch Superficies will be			
	For the firſt Size	22	Men.
	For the ſecond Size	20	
	For the third Size	15	
	For the fourth Size	11	
	For the fifth Size	8	
	For the ſixth Size	5	

I proceed now to ſhew the Proportion of the Material and Workmanſhip for Calking and Paying the Work from the Water's Edge upwards, which being Two-fold, I ſhall conſider them as follows.

For new Calking there will be a Compound Fraction made by the Number of Seams, Thickneſs of Plank, and the Medium Length, to find the Proportion of the Oakham ſufficient to fill the Seam, and the Superficial Area only for to Proportion the Oakham ſufficient to Calk the Rents and Trenels; but however, I ſhall content my ſelf to make a Compound Fraction with the Number of Seams, Thickneſs of the Plank, and the Superficial Area from the Upper-wale to the Top of the Ships ſide, to find the Quantity of Oakham for all the Work and Workmanſhip, and ſhall deduce it from my old Standard the ſix ſized Ship.

The Superficial Area from the Wale to the Top of the Ship's ſide is		Feet.
	In the firſt ſized Ship	8832
	In the ſecond ſized Ship	7392
	In the third ſized Ship	4424
	In the fourth ſized Ship	3788
	In the fifth ſized Ship	2464
	In the ſixth ſized Ship	1728

Then the Proportion of that Superficial Area will be one ſized Ship to the other		
	The firſt Size to the ſecond will be as	6 to 5
	The firſt Size to the third will be as	2 to 1
	The firſt Size to the fourth will be as	9 to 3
	The firſt Size to the fifth will be as	11 to 3
	The firſt Size to the ſixth will be as	26 to 5

The Proportion of the Planks thickneſs one to another		
	The firſt Size to the ſecond is as	9 to 8
	The firſt Size to the third is as	9 to 7
	The firſt Size to the fourth is as	9 to 6
	The firſt Size to the fifth is as	18 to 11
	The firſt Size to the ſixth is as	2 to 1

The Proportion of the Seams is one to another as		The Number being in the ſeveral Sizes,			
	8 to 7		First	24	Seams.
	8 to 5		Second	21	
	8 to 5		Third	15	
	12 to 7		Fourth	15	
	2 to 1		Fifth	14	
			Sixth	12	

The Compound Fractions will ſtand thus,

The firſt Size to the ſecond. The $\frac{5}{6}$ of the $\frac{8}{9}$ of the $\frac{7}{8}$, which being multiply'd is

$$\begin{array}{r} 8 \\ 5 \\ \hline 40 \\ 7 \\ \hline 280 \end{array}\ \text{Numerator.} \qquad \begin{array}{r} 9 \\ 6 \\ \hline 54 \\ 8 \\ \hline 432 \end{array}\ \text{Denominator.}$$

The Fraction is $\frac{280}{432}$.

Reduc'd it is $\frac{3}{4}$.

The first to the third. The $\frac{1}{9}$ of the $\frac{7}{8}$ of the $\frac{5}{2}$, which being multiply'd is

$$\begin{array}{r} 7 \\ 1 \\ \hline 7 \\ 5 \\ \hline 35 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 8 \\ 9 \\ \hline 72 \\ 2 \\ \hline 144 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{35}{144}$.

Reduc'd is $\frac{1}{4}$.

The first to the fourth. The $\frac{3}{7}$ of the $\frac{6}{9}$ of the $\frac{5}{8}$, which being multiply'd is

$$\begin{array}{r} 6 \\ 3 \\ \hline 18 \\ 5 \\ \hline 90 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 9 \\ 7 \\ \hline 63 \\ 8 \\ \hline 504 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{90}{504}$.

Reduc'd is $\frac{5}{28}$.

The first to the fifth. The $\frac{3}{11}$ of the $\frac{11}{18}$ of the $\frac{7}{12}$, which being multiply'd is

$$\begin{array}{r} 11 \\ 3 \\ \hline 33 \\ 7 \\ \hline 231 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 18 \\ 11 \\ \hline 18 \\ 18 \\ \hline 198 \\ 12 \\ \hline 396 \\ 198 \\ \hline 2376 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{231}{2376}$.

Reduc'd it $\frac{1}{10\frac{2}{7}}$,

The first to the sixth. The $\frac{5}{26}$ of the $\frac{1}{2}$ of the $\frac{1}{2}$, which being multiply'd is

$$\begin{array}{r} 5 \\ 1 \\ \hline 5 \\ 1 \\ \hline 5 \end{array} \text{ Numerator.} \qquad \begin{array}{r} 26 \\ 2 \\ \hline 52 \\ 2 \\ \hline 104 \end{array} \text{ Denominator.}$$

The Fraction is $\frac{5}{104}$.

Reduc'd is $\frac{5}{104}$.

Then

Then the Proportion of the Black Oakham will be			
The firſt Size to the ſecond as	14	to	9
The firſt Size to the third as	144	to	35
The firſt Size to the fourth as	280	to	50
The firſt Size to the fifth as	1020	to	100
The firſt Size to the ſixth as	104	to	5

Then the Proportion for the White Oakham and all the other Materials will be			
Firſt Size to the ſecond as	6	to	5
Firſt Size to the third as	2	to	1
Firſt Size to the fourth as	7	to	3
Firſt Size to the fifth as	11	to	3
Firſt Size to the ſixth as	26	to	5

Then the Materials and Workmanſhip will be as follows, to dreſs a Ship of each Size from the Wale to the Top of the Side.

	C.	*q.*	*l.*
The ſixth Sizes black Oakham as Cuſtom is	4	0	0
The firſt Sizes Black Oakham from that Proportion will be	83	0	0
Second Sizes ditto	54	0	0
Third Sizes ditto	20	1	0
Fourth Sizes ditto	14	3	0
Fifth Sizes ditto	8	0	1

The White Oakham from that Proportion will be	*C.*	*q.*	*l.*
	0	2	0
	2	1	8
	1	3	24
	1	0	18
	1	0	0
	0	2	11

The Oyl from that Proportion will be	*Gallons.*
	4
	$20\frac{3}{4}$
	$17\frac{1}{2}$
	$10\frac{3}{8}$
	$8\frac{7}{8}$
	$5\frac{3}{4}$

The Pitch from that Proportion will be	*Barrels.*
	2
	$10\frac{4}{10}$
	$8\frac{3}{4}$
	$5\frac{2}{10}$
	$4\frac{1}{2}$
	$2\frac{17}{20}$

The Tar will be from that Proportion		*Barr.*	*Gall.*
	Firſt Size	3	28
	Second Size	3	8
	Third Size	1	30
	Fourth Size	1	21
	Fifth Size	1	2
	Sixth Size	0	24

The Thrums will be from that Proportion.	*l.*
	$20\frac{3}{4}$
	$17\frac{1}{2}$
	$10\frac{6}{10}$
	$8\frac{9}{10}$
	$5\frac{3}{4}$
	4

The Leather will be from that Proportion	*l.*
	$2\frac{1}{8}$
	$2\frac{1}{10}$
	$1\frac{1}{4}$
	$1\frac{4}{10}$
	$0\frac{7}{10}$
	$0\frac{1}{2}$

The Twine will be from that Proportion	*l.*
	$2\frac{1}{2}$
	$2\frac{1}{10}$
	$1\frac{1}{4}$
	1 [illegible]
	$0\frac{7}{10}$
	$0\frac{1}{2}$

The Candles will be from the ſame Proportion		*Pounds.*
	Firſt Size	15 [illegible]
	Second Size	13
	Third Size	$7\frac{3}{4}$
	Fourth Size	$6\frac{6}{10}$
	Fifth Size	$4\frac{1}{3}$
	Sixth Size	3

The Buckets from the ſame Proportion will be	*Number.*
	15
	12
	7
	6
	4
	3

The

The Laſhing Rope will be from the ſame Proportion	Coils.	The Deals from the ſame Proportion will be	Number.	The Workmanſhip will be worth from the ſame Proportion	l.	s.	d.
	2 1/8		31		180	16	0
	2 1/16		30		120	00	0
	1 1/4		27		45	10	0
	1 4/30		23		33	10	0
	0 7/16		19		18	10	0
	0 1/2		6		9	00	0

Which Calculation includes Decks and all the Work within Board, altho' I have not taken the Superficial Area of the Decks in, for ſince I make uſe of the ſixth ſize Ship for a general Standard, it will correſpond and mutually agree, and I am alſo poſitive that it will be nice enough for Practice. However, for a greater Niceneſs, I will proceed to make another Calculation; and firſt for the Charge of the Material and Workmanſhip for the upper Work, meaning all ſuch Work that is above the Wale, both within-ſide and without-ſide.

The ſuperficial Area's are from the Wale to the Top of the Side		Feet.
	Firſt Size is —— ——	8832
	Second Size is —— ——	7392
	Third Size is ——	4424
	Fourth Size is —— ——	3788
	Fifth Size is —— ——	2464
	Sixth Size is —— ——	1728

The Area's of the Decks accordingly are	Feet.	The Superficies of Sides and Decks added together are	Feet.
	25738		34570
	21937		29329
	12982		17406
	9433		6221
	6572		9036
	3718		5446

Then the Proportion of the Area's of the Decks and Sides are		
	Firſt to ſecond as ——	7 to 6
	Firſt to third as ——	10 to 7
	Firſt to fourth as ——	8 to 3
	Firſt to fifth as ——	19 to 5
	Firſt to ſixth as ——	19 to 3

Then the Charge of the Material and Workmanſhip for each Rate to dreſs the upper Work will be		l.	s.	d.
	For the firſt Size —— ——	138	0	0
	For the ſecond Size —— ——	118	0	0
	For the third Size —— ——	97	0	0
	For the fourth Size —— ——	52	0	0
	For the fifth Size —— ——	36	10	0
	For the ſixth Size —— ——	21	17	6

Then for the Charge of Graving and Cleaning under Water, I take the Area of the Bottom under the Wale down to the Keel, to gain a Proportion, ſtill continuing my old Cuſtom of making the ſixth ſized Ship the Standard to gain a Proportion for the reſt.

Then the Proportion of the Area from the Wale to the Keel will be		
	The firſt Size to the ſecond as ——	9 to 8
	The firſt Size to the third as ——	13 to 9
	The firſt Size to the fourth as ——	2 to 1
	The firſt Size to the fifth as —— ——	20 to 7
	The firſt Size to the ſixth as —— ——	25 to 6

Then

		l.	*s.*	*d.*	
Then the Charge of Cleaning and Graving will ſtand thus	The firſt Size is ——	36	15	0	
	The ſecond Size ——	32	00	0	But not the Charge of Docking put in.
	The third Size ——	25	04	0	
	The fourth Size ——	18	04	0	
	The fifth Size ——	12	14	0	
	The ſixth Size ——	8	15	6	

You are alſo to take Notice, that theſe Prices are what I allow, provided the Materials are at the ſame Rate with what I have mentioned in Page 151. And as the Materials riſe and fall, the Total Charge of doing ſuch Work, and making Uſe of ſuch Goods, will undeniably be reciprocal to the Variety of the Price, and therefore the Times and Seaſonableneſs of obtaining the Ingredients proper for every Service, ought firſt to be enquired into before an abſolute Bargain can be made, but undeniably the intrinſick Proportion of one Ship to another, will certainly anſwer according to the ſuperficial Area's that are contained in one Ship more than there is in another; ſince 10 Foot on the ſixth ſized Ship will be Equivalent to 10 Foot on the firſt ſized Ship, and ſo on to any of the other; the Labour will certainly be no more in one than in the other, according as their ſuperficial Inches are one to the other; and the ſame may moſt certainly be ſaid of the Materials.

But this Equality will be found only in the Reparations, as in Calking and Cleaning, alſo in Graving, as this latter Calculation doth wholly imploy; for on the other Hand double new Seams will require double Labour, and muſt have a Twofold Conſideration.

You are alſo to obſerve, that there is no Shipwright's Work allowed of in theſe Calculations, only purely the Calker's Work, and the Materials belonging to the ſame, and all the Square-making (as Shipwright's term it) as ſhifting of Planks, driving of Trenels, and the like, is brought in upon another Charge.

I proceed now to conſider of ſuitable Proportions for Calking of new Oak Plank, with the Length of the Seam that ſhall be deem'd one Day's Work, and what a Night or a Tide means; and in doing of which, if I was to continue the old Method, I ſhould proportion the Number of Threads of Oakham or Hair, agreeable to the Thickneſs of the Plank, which I believe to be ſuperfluous, and although mentioned there, yet notwithſtanding it cannot be comply'd with, except the Seams were proportion'd according to my preceeding Obſervation of nicely ſaying the Plank's Edges, and making them of an equal Gauge, according to their various Thickneſs; which if they were ſo wrought, the Oakham might be as nicely proportion'd, as an Inch Rope for an Inch Block, and that black Oakham Threads might by Weight be proportion'd for their ſeveral and reſpective Seams, according to their equal Diſtances, and Niceneſs in laying, by which Means you may moſt exactly know whether any Ship is ſufficiently Calked, and the Rifts or Seams ſuitably fill'd, and not by the Guidance of a poor little ignorant Oakham-Boys ſpinning; and then ſay ſo many Threads of black Oakham or white Oakham will be ſufficient to fill ſuch and ſuch Seams, according to the Variety of the Plank's Thickneſs, and the Spinning of the poor little unexperienc'd Baby.

I have really ſeen ſeveral experienc'd Calkers at ſome Times eaſe their Stroke, and at other Times force it, and yet in the very ſame Seam, and in a ſhort Diſtance, which by any reaſonable Man cannot be allowed for good Work. But to proceed, in the next Place, to proportion the Length of Seam that ſhall be deem'd a Day's Work.

By the preceeding Calculation, a Calker muſt Calk for one Day's Work in the ſeveral Thickneſs of Plank as follows.

Thick-

Thickneſs of the Plank. Inch.	Feet.
10	23
9	25½
8	28¾
7	32
6	38⅓
5	46
4	56¼
3	78
2	115
1½	156
1	226

Length of the Seam which I deem a Day's Work, and the Proportion will be as follows.

Inch.		Inch.				
10	to	9	as	9	to	10
10	to	8	as	4	to	5
10	to	7	as	5	to	7
10	to	6	as	3	to	5
10	to	5	as	1	to	2
10	to	4	as	9	to	22
10	to	3	as	5	to	17
10	to	2	as	1	to	5
10	to	1½	as	14	to	95
10	to	1	as	23	to	226

But the Accuſtomary Proportions are as follow,

Inch.		Inch.				
10	to	9	as	27	to	28
10	to	8	as	13	to	14
10	to	7	as	9	to	10
10	to	6	as	10	to	12
10	to	5	as	9	to	11
10	to	4	as	3	to	4
10	to	3	as	7	to	12
10	to	2	as	8	to	18
10	to	1½	as	5	to	16;
10	to	1				

The ſeveral Feet of Seam deem'd a Day's Work, both as to Cuſtom, and alſo by my own Obſervation, is ſet down in ſeveral diſtinct Tables preceeding this.

Now whether the Accuſtomary Rules were right or not, I ſhall refer; that the abſolute Deciſion may be made by the judicious Reader, rather than to enter into Arguments at preſent: However, methinks I cannot wholly ſuſpend this Obſervation, without drawing one Parallel between Calking of 10 Inch Plank and 2 Inch Plank, their Thickneſs is plainly as 5 to 1, and yet the Number of Feet deem'd to be Calked for one Day's Work in 2 Inch Plank is but 32, and the Number of Feet in 10 Inch Stuff is 13 Feet 6 Inches, which is but as 19 to 8. Now whether it be allowed that 10 Inch Stuff ſhall be Calked but half Way, I refer to thoſe Experienc'd Calkers that ought to know; for if the Seams be required to be equally fill'd the Proportion formerly made will not anſwer.

As to the General Allowance of Nights and Tides to Day Works, I am of Opinion, that it can never be expected for any Man to do as much in 5 Hours after his Day's Work is complied with, as he can, when freſh come to it, and but juſt begun; which 5 Hours is the Time approved on as a Standard for a Night, and the Pay for the ſame made equal to the Day's Allowance; and therefore in my Opinion, this Extraordinary Allowance was given to encourage the Artificer, and cauſe him to follow his Stroke heartily, without much Intermiſſion or Diſcontinuance, and to diſpatch what Work he reaſonably can, during that ſtinted Time: As it's often Proverbially ſaid, that one Man may lead a Horſe to the Water, but twenty Men will not be able to make that one Horſe drink; ſo in our Caſe you may conſtantly attend on the Working Man, and he may alſo ſeem very forward in his Imployment, and yet but to very little purpoſe: Beſides I am poſitive, that a very mean Shipwright can earn more than 25 Pence in eleven Hours, which is our common Day's Time as Cuſtom, and at ſome Time an Hour leſs, according to the Seaſon of the Year. But to go yet further on this Subject, you may obſerve in this Volume, where I have proportion'd the Tasking of Shipwright's Work, that I allow ſome Shipwrights may very eaſily earn 5 *s.* in 10 or 11 Hours, and but ordinary ones 3 *s.* in the ſame Time, and perhaps the worſer Sort not able to earn 6 *d.* in ſuch a Time; ſo that if ſuch Prices as I have there mentioned ſhould be any way lower'd or leſſen'd, ſuch piddling, bungling Swains muſt inevitably be ſtarved.

Indeed it would be much better for the Publick, and for every Day Labourer, if all Ship-work was lump'd or task'd; but then perhaps ſome would object, that the Work may be ſlighted, which may prove of dangerous Conſequence in the Duration of a Ship above all other Work, which moſt certainly is no other than Amuſement; for are not the Rigging and Anchor's Materials of as high a Nature as the Ship, ſince they are her Grand Safeguard, and yet every Stitch of ſuch Materials are let out to perform by the Piece.

Another Objection which I expect is, that it will laſh hard upon Servants and Men in Years, which I am apt to believe will ſtill be found otherwiſe; ſince few Men lives to that Age (in ſuch a Laborious Calling) but that they may earn above 25 Pence *per* Diem, and therefore I cannot ſee how any Man is a Debtor, if he earns 4 *s.* a Day for 27 Years, that is, from the Years of 23 to 50; for ſo long a Man may hold it, and from 50 to 60 Years he may earn 25 Pence *per* Day, and provided a Man was kept from 60 to the 70th Year of his Age wholly Idle, there would be 20 Years Labour for 10 Years being Idle, which is 2 for 1; and as for the Apprentices, I am poſitive very few, nay ſcarce any, but from the beginning of his Servitude to the latter end, conſiderably over-tops the common Allowance of Wages, which is generally given to them; ſo that here is a Matter hood-wink'd, which would be univerſally Beneficial, was it but put in Practice; and then to the nice Inſpection, it may be much eaſier and better made by the ſame Number of Overſeers as is now appointed, ſince the Neglect ought to be charged on the Overſeers; and if once the Lumpers (as I ſhall term them) was detected, put back and hinder'd, nay, and made to pay for the Material they wrong applied, they would be extreamly backward from attempting to do the like again, but in deficiency of Judgment they would rather Adviſe with the Overſeer, then run counter to their own Intereſt, as well as to the Publicks.

Now ſince the common Maxim is, that if a Perſon rides Poſt, he ought to pay Poſt Miles, intimating that if a Man is in haſte, he ought to pay ſomething extraordinary for the Diſpatch, and therefore this extraordinary Allowance which is made for Nights and Tides, is given on preſſing Emergencies, when the Imployer is neceſſitated to diſpatch ſome weighty Buſineſs, notwithſtanding this is no where allowed but in ſuch Places where able Men have but half what they often do, and can reaſonably earn; ſo that for ſuch able Men, the Tides Allowance is really right, and what the Artificer moſt certainly earns, and the common Day's Work is but half what in Juſtice ſuch able and experienc'd Men ought to have, in caſe he continues at his Buſineſs and follows his Strokes, which will plainly appear to the Overſeer whether he doth or not.

Beſides, as to the ancient Men, and ſome others incapacitated for Diſpatch, was it to be rightly conſidered, there is Abundance of ſmall Materials that are made out of Wood (nay, may be made out of the Waſte of Timber that turns but to little Account) which would employ ſuch Men, and cauſe them to earn more than the common Allowance; ſuch as Handſpokes, Wrainſtaves, and Port-bars; alſo to make and moot Trenels, Mouth and Chamfer Wedges, and Abundance of other petty Materials that ſtands all Yard-keepers a conſiderable Sum of Money to provide in Building and Rebuilding any Ship; nay, was there ſuch decrepit Men put to make Sticks to lay between Planks for airing them, alſo one or more experienc'd Shipwright to look, and be always in the Plank Yard, to obſerve and direct the cutting of Plank, alſo for Chipping or Taſting it, and the like, it would moſt certainly turn to Account, eſpecially in ſuch Places as have ſuch large Quantities of chargeable Plank laid in great heaps. But to proceed in the next Place to ſhew a Proportion for the Number of Men and Days requiſite to Calk a Ship;

Size and Tunnage of 6 Ships.		Price *per* Tun of each Size.		Total Sum for Calking each Ship.		
Size.	*Tunnage.*	*s.*	*d.*	*l.*	*s.*	*d.*
Firſt	1700	3	6	298	0	6
Second	1400	3	1½	226	2	3
Third	1004	2	7½	131	5	6
Fourth	670	2	6	83	15	6
Fifth	370	2	6	46	5	0
Sixth	261	2	1	27	3	9

I firſt Proportion the Number of Days to Calk each Ship, according as the Area's are one to another, allowing every able Calker 4 *s. per* Day.

Number of Days that they may be calked in.	The Number of Men that may do it in ſuch a Number of Days.
40¼	37
25 1/7	22
24½	27
19	22
12¼	19
8¼	16

Then the Proportion of the Men will be one to another,

The firſt Size to the ſecond as —— 8 to 7
The firſt Size to the third as —— 11 to 8
The firſt Size to the fourth as —— 5 to 3
The firſt Size to the fifth as —— 31 to 16
The firſt Size to the ſixth as —— 7 to 3

The Proportion of the Days will be one to another

Firſt Size to the ſecond as —— —— 8 to 7
Firſt Size to the third as —— —— 13 to 8
Firſt Size to the fourth as —— 15 to 7
Firſt Size to the fifth as —— —— 10 to 3
Firſt Size to the ſixth as —— —— 10 to 2

The Proportion of the Men and Days put together will be as

8 to 7
3 to 2
17 to 9
5 to 2
16 to 5

You are to obſerve in this Calculation, that I have proportion'd my Days allowed for Calking each Ship, from the Superficial Area that is contained from the Keel to the Top-timber Head, and the Number of Men I produce from dividing the whole Money, and allowing every Calker 4 *s. per* Day; which Calculation comes very near that which was formerly made, if you look backward and compare the Proportions together; ſo that it's very plain and obvious, that a Calker's bare Day's Work, or 10 Hours, has been proportion'd at 4 *s.* for each Calker, and ſo in Proportion for the Tides.

I proceed now to ſhew another Calculation for Tallowing and Graving any Ship under Water, in which I ſhall be guided by the Area of each aforemention'd Sizes, from their Keels to the Wale, and ſhall make uſe of my former Standard the ſixth ſized Ship, to gain a Proportion for the Allowance of Stuff for all the reſt.

The Proportion of the Area from the Keel to the Wale is

The firſt Size to the ſecond as —— 9 to 8
The firſt Size to the third as —— 13 to 9
The firſt Size to the fourth as —— 2 to 1
The firſt Size to the fifth as —— 20 to 7
The firſt Size to the ſixth as —— 25 to 6

Then

	C.	q.	l.
Then the ſixth ſized Ship's Tallow as Cuſtom being	4	2	9
The firſt ſized Ship's Tallow will be	18	3	19
The ſecond ſized Ship's Tallow will be	16	3	8
The third ſized Ship's Tallow will be	13	0	9
The fourth ſized Ship's Tallow will be	9	1	24
The fifth ſized Ship's Tallow will be	6	2	10

	Barrels.
The ſixth ſized Ships Pitch as Cuſtom is	3
The firſt ſized Ships Pitch will be	12$\frac{1}{2}$
The ſecond ſized Ships Pitch will be 11	1l.
The third ſized Ships Pitch will be	8$\frac{3}{4}$
The fourth ſized Ships Pitch will be	6$\frac{1}{4}$
The fifth ſized Ships Pitch will be	4$\frac{1}{2}$

	Barrels.
The ſixth ſized Tar is	1$\frac{1}{2}$
The firſt ſized Tar is	6$\frac{1}{2}$
The ſecond ſized Tar is	5$\frac{1}{2}$
The third ſized Tar is	4$\frac{1}{2}$
The fourth ſized Tar is	3$\frac{1}{8}$
The fifth ſized Tar is	2$\frac{3}{16}$

	Barrels.
Sixth ſized blacking Barrels is	1$\frac{1}{2}$
Firſt ſized blacking Barrels is	6$\frac{1}{4}$
Second ſized blacking Barrels is	5$\frac{1}{2}$
Third ſized blacking Barrels is	4$\frac{1}{2}$
Fourth ſized blacking Barrels is	3$\frac{1}{8}$
Fifth ſized blacking Barrels is	2$\frac{3}{16}$

	C.	q.	l.
Sixth ſized Brimſtone is	1	1	0
Firſt ſized Brimſtone is	4	0	20
Second ſized Brimſtone is	3	3	0
Third ſized Brimſtone is	2	3	10
Fourth ſized Brimſtone is	2	0	10
Fifth ſized Brimſtone is	1	1	22

	C.	q.	l.
Sixth ſized Rozam is	7	2	0
Firſt ſized Rozam is	31	0	0
Second ſized Rozam is	27	2	0
Third ſized Rozam is	21	2	0
Fourth ſized Rozam is	15	2	0
Fifth ſized Rozam is	10	3	0

	Gallons.
The ſixth ſized Oyl is	10
The firſt ſized Oyl is	41$\frac{1}{2}$
The ſecond ſized Oyl is	37
The third ſized Oyl is	28$\frac{1}{4}$
The fourth ſized Oyl is	20$\frac{3}{4}$
The fifth ſized Oyl is	14$\frac{1}{2}$

And to apply theſe Calculations yet farther, I ſhall add a brief Method to find the Superficial Area of the Lower Deck on Board of any Ship near enough for common Practice, and that is to multiply the $\frac{10}{11}$ of the Length on the middle Line, by the Breadth on the inſide of the Ship at the broadeſt Place, and with only minding the Waſte in Hewing and Laying the Plank of the ſaid Deck, which will be ſomething, this ſame Method will gain the Superficial Contents of Plank proper to lay or cover ſuch a Deck.

Then the Superficial Area of the Middle Deck to the Lower Deck will be as 12 to 13.

The Area of the Lower Deck to the Superficial Area of the Upper Deck in two Deck Ships is as 3 to 2.

Notwithſtanding it will in ſome Meaſure depend on the various tumbling Home of the Side, in one Ship more than what may be found in another of equal Breadth; however, theſe Rules may very well ſuffice.

The Superficial Area of the Work from the Keel to the Lower Wale on both ſides, will be nearly found by multiplying the extream Length on the Lower Gun-Deck, by the extream Breadth from out-ſide to out-ſide at the broadeſt Place of the Ship.

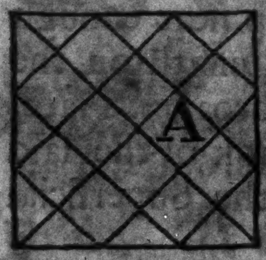
The Superficial Area of the Plank from the Upper Wale to the Top-timber Head, will be found by multiplying the extream Length on the Lower Gun Deck, by the Height of both Sides on the tumbling Home of the Side, from the Wale to the Top of the Planſheer, Abaft the Main-Maſt, obſerving that the Superficial Area of the Lower Wale, between the Wale, and the Upper Wale, is very near $\frac{2}{11}$ of the Ship's Bottom, from the Keel to the Lower Wale; and after ſuch a manner may very eaſily be found the Superficial Area's of any

Ship, or any Part of her; and ſo I proceed to make ſome uſeful Calculations of a leſſer Account.

Firſt, to find the Number of Trenels, you may multiply the Number of Timbers, or the Ledges on a Deck, by twice the Number of Strakes of Plank; as for inſtance, let a Ship have 50 Timbers and 10 Strakes of Plank, then multiply 50 by 20, it is 1000; which is the Number of Trenels that will be ſufficient to faſten that Work, ſince it is general to have two Trenels through every Timber and Plank; notwithſtanding, where the Cuſtom is to drive all the Trenels that faſtens the Out-board Plank out again, by reaſon of having all Trenels drove through both Planks and the Timber: I ſay in ſuch a caſe there muſt be allowed half the Number extraordinary, for the Advantage of well faſtening the Work, and making it more durable.

The ſame may be ſaid of the Nails in the Deck, to multiply the Number of Beams by twice the Number of Strakes of Plank, it will give you the Number of Nails requiſite to faſten the Planks to the Beams; and where the Nails are drove into the Ledges, the ſame Calculations will ſuffice, if you multiply the Number of Ledges by twice the Number of Strakes.

Such Methods would alſo inform us of the Quantity of Iron Bolts exactly, only to multiply the Number of Knees by the Number of Bolts; but ſince the ſhape of Knees are various, according to the Diverſity of Shapes in a Ship, and of Conſequence the Bolts longer or ſhorter according to ſuch different Shapes, and the Bolts lighter or heavier, agreeable to the ſame; I ſay therefore in ſuch caſes Experience muſt be our beſt School-maſter, to know exactly the Tuns of Iron that will be ſufficient, and agreeable to the Tunnage of the Ship: However, ſince I have been very particular on that Subject in this Volume at Page 87, I ſhall ſay nothing more of it here, but ſhall proceed to ſhew you a Method how to know what Number of Sheathing Nails, and from thence the Quantity of the ſame that will be requiſite to faſten the Sheathing on any Ship, or indeed any ſuch Chequer'd Work.



And to know ſuch a certain Number, is no other than to Chalk out what Diſtance you deſign to place your Nails in one Foot of Board; then multiplying the Superficial Area contained in ſuch a Sheathing, by the Number of Nails you deſign in every Foot, and it will give you the whole Number of Nails requiſite to faſten the Work, as for inſtance in the Figure A. Let it be a Piece of Board one Foot Square on the Superficies, and the Nails to be placed at 3 or 4 Inches aſunder, and notwithſtanding at equal Diſtance; as you may obſerve in the Figure, that there will be by ſuch a Diviſion 13 Nails in ſuch a Superficies, and that the Superficial Feet to be covered or ſheathed is to be 10000 Foot, then multiplying 10000 by 13, it is 130000, which is the Number of Nails that will be ſufficient to faſten ſuch a Quantity of Sheathing Board; then reducing ſuch a Number into Weight, you will have the exact Hundreds or Pounds that will be proper to do any Piece of Work of that or the like Nature.

OF

OF
PITCH and TAR.

TAR and Pitch in Ship-building being generally uſed by the Calkers, I ſhall therefore put in what I have to ſay on ſuch Materials, ſubjoining it to their Branch of Duty.

Tar is produced from the Knots of Fir-Trees, by a ſort of Diſtillation, and of Tar Pitch is made by boyling the Tar, whereby it becomes ſtiffer and drier.

The Price of the imported is generally as 3 to 2, that is, if a Barrel of Pitch is valued at 30 *s.* a Barrel of Tar is valued at 20 *s.* and the common Weight of a Barrel of Pitch is 3 Hundred, or rather ſomething more than leſs, meaning Groſs Hundreds. The Barrel of Tar is alſo 32 Gallons, or thereabouts, and each Gallon is counted 282 Inches, which in 32 Gallons amounts to 9024 Inches; alſo a Gallon of Tar is 10 Pound and a half; ſo that the Weight of a common Barrel of Tar ſhould be 336 Pound, and the Barrel of that is 56 Pound. The Cubick Feet in a Barrel of Tar is 5 Foot and $\frac{2}{9}$ of a Foot, and in a Barrel of Pitch the Feet are 4, which being 6912 Inches, the Difference in Inches between a Barrel of Pitch and a Barrel of Tar is 2112 Inches, which is the Number of Inches contained more in a Barrel of Tar than in a Barrel of Pitch; from which the Proportion of Inches will be as 13 to 10, but the Proportion of the Weight in common Barrels of Tar and Pitch is generally equal: That its very probable that a Barrel of right good Tar will produce one Barrel of right good Pitch, according to their various Content afore-mention'd, or 24 Gallons and a half, which is according to the Number of Inches contain'd in a Barrel of Pitch; from which it appears, that the Waſte in Boyling will be 7 Gallons and a half, or near $\frac{1}{4}$ of the whole; which $\frac{1}{4}$ Waſte, together with the firing, fitting Utenſils, and Day Labour to make it, may be deem'd $\frac{1}{3}$; and this Obſervation will be very agreeable to the different Price, provided it was, as it muſt needs ſeem to the Contractors, that the Cubick Feet in a Barrel of Pitch were equal to the Cubick Feet contain'd in a Barrel of Tar, ſince their Weight is equal one to another, but the Caſe is quite different; tho' the Weight be equal and alike, the Gallons are as 13 to 10, as well as the Number of Inches, and therefore this $\frac{1}{3}$ Difference in the Price is purely advanced for the Firing and Labour, and the Utenſils fitting to Boil it, ſince the Waſte made by Boiling is allowed in the Difference there is between the Barrels; of which I ſhall more particularly conſider hereafter.

Mr. *Evelyn* in his *Sylva* tells us, that one Mr. *Winthorp* preſented the *Royal Society* with a Proceſs of making Tar and Pitch in *New England*, which he thus abreviates. Tar is made out of a ſort of Pine Trees, from which naturally Turpentine extilleth, and which at its firſt flowing out is Liquid and Clear; but being hardned by the Air, either on the Top of the Tree, or wherever it falls, is not much unlike the *Burgundy* Pitch; they grow upon the moſt barren Places: Of Tar, by Boiling to a ſufficient Height, is Pitch made, and in ſome Places where Roſin is plentiful, a fit Proportion of that may be diſſolved in the Tar whilſt it is Boiling, and this Mixture is ſooneſt converted to Pitch; but it will be ſomewhat of a different kind from that which is made of Tar only, without other Compoſition: However, the way for Diſpatch and ſudden Uſe is to heat the Tar very hot, and ſet it on fire, which it will very eaſily do, letting it burn ſo long, till taking out ſome ſmall Quantity for Tryal, being cold, it appears of a ſufficient Conſiſtence; then covering the Kettle cloſe the Fire is extinguiſh'd, and the Pitch made without any more Ceremony. There is a Proceſs of making Roſin alſo out of the Knots, by ſplitting them out into thin Pieces, and Boiling them in Water, which will Educe all the Reſinous Matter, and that will harden into Roſin. He concludes the Diſcourſe by telling how he is of a ſtrong Opinion, that the Pines and Fir Trees in *Scotland* might yield her Majeſty plenty of excellent Tar, were ſome iuduſtrious Perſon employed about the Work.

Our Chymical Shipwrights will tell us, that they can with ſome Mixture put in at Boiling the Tar, produce 5 Barrels of Pitch out of 6 Barrels of Tar; then 6 Barrels of Pitch containing 24 Foot, and 6 Barrels of Tar containing 31 Foot and $\frac{1}{3}$ of a Foot, the Product in Feet is near $\frac{3}{4}$, and if ſo, it would be much cheaper to have all Tar tranſported, and make Pitch of it in *England*, ſince for every 8 Pound you would have 9 Pounds worth of Goods, which would be one Pound advanced in 8 for Labour and Fewel, and would really turn to Account in a large Quantity of ſuch Materials; but referring ſuch Chymical Obſervations to be more fully conſidered by the Chymical Inquirers, I ſhall juſt inſtance what I have obſerved in a Tryal made in his Majeſty's Yard at *Deptford* on his Majeſty's Ship the *Tilbury*; but before I proceed it will not be very improper to give you an Account of the Source of Tryals in General, but more particularly of this.

You may obſerve, that the World began with Project when there was but three Perſons in it, as we may read in Sacred Hiſtory: They grew outragious purely about the Notion they had of their Ability, one envying another, and furiouſly diſputing which was the greateſt Proficient in his particular Art and Science, that he more immediately practiſed; which Temper in Men, as it firſt was introduced with Miſchief and Envy, ſo it ſtill continues in Diſorder, ſince every Man is puff'd up with a Notion of his Ability, tho' it be ever ſo mean, and the Opinion which the general Part of Mankind has of him, be ever ſo contrary to his own.

But not to inſiſt any farther on Project in General, I ſhall proceed to ſhew the Occaſion of the Tryal that is before-mention'd, which was to cover a Ship with ſuch a Mixture under Water, that ſhould preſerve the Plank from the Worms, without covering her with Sheathing Board, which is our greateſt Preſervative againſt that Animal, obſerving not only how Chargeable the Sheathing of Ships Bottoms is, but alſo that its very pernicious, and altogether deſtructive to the Ship's Planks on which it is nail'd; the Plank at the Sheathings being pull'd off, is not much better for Service (provided another Sheathing is not applied) than if the Worm had eat the ſame, ſince the Nails will as effectually ſplit and tear the Plank to Pieces, as the Worm will eat it to Pieces, and therefore in very ſmall Ships the Difference will not be much, whether you ſhift all the Plank in the Ships Bottom, or put on a new Sheathing.

Indeed ſuch Faculties, which are generally incident to Ships, has put ſeveral (beſides this Gentleman) upon Thoughts how to prevent ſuch Diſorder in the Machine, believing if they could propoſe any thing that would be in any manner ſerviceable to the Publick, they ſhould be ſuitably rewarded for doing the ſame.

However, the Mixture being propoſed to be highly neceſſary for preſerving Ships Bottoms from the Worms, it is accordingly try'd; but as to the Proof I never inquired: However, it was a very hard Mixture, almoſt too hard to be melted with a mean Fire, and being laid on upon the Ship like poliſhing, ſo very thin, ſcarce diſcernable to Appearance that the Plank was any ways covered, only by gliſtering; but ſuſpending ſuch Chymical Preparations at preſent, I ſhall proceed to give ſome neceſſary Cautions towards the Uſe of the common Pitch and Tar, and alſo in Merchandizing for it.

I ſay in Merchandizing for Pitch and Tar, great Care ought to be in buying ſuch as is prime good, for Defects in either is very detrimental to the Managers, ſince I have obſerved one great Trick in Tar, and that is to make good the Wants that may happen (by Leakage or Waſte) with Fir Saw-duſt; but however, that Sham is very eaſily diſcovered, not only by the Thickneſs of the Tar, wherein you may perceive that there is ſome Duſt in it, but by weighing of it you may exactly know how much right good Tar there is contained in the Barrel, and how much Saw-duſt, or any ſuch adulterated Matter that there is in the ſame, ſince Saw-duſt of Fir (altho' of the ſame Conſiſtence) is much lighter than the Juice that flows from it, and therefore all that you have to do is to know the Specifick Gravity of each, which will guide you in knowing whether what you are Merchandizing for agrees with ſuch a Standard, according to the Quantity you are dealing for, which will make you ſafe and ſure that the Commodity is of a right good ſort: Notwithſtanding a nice Inſpection may do without ſuch Tryals, ſince the true Juice and well diſtill'd Tar muſt certainly appear bright and very clear, like a perfect Liquid Subſtance that flows from a Limbeck.

I doubt not but that there are ſome other Artifices to mix and adulterate ſuch a Commodity, to the Advantage of a tricking Vendor, all which being highly detrimental to the Buyer, and therefore worthy of Inquiry, ſince the Damage will not only reſt in the Tar, but it's alſo a Loſs in making the Tar into Pitch, and as commonly practiſed as can be, to make Pitch out of damaged Tar; but however that muſt be done by thoſe well accuſtomed in doing of it, ſince it's really very hazardous to make Pitch from Tar that is not very good.

I have in *Virginia* attempted to make Pitch from damaged Tar; but as ſoon as ever the Tar grew hot, all the Artifice in Nature could ſcarce keep any in the heating Pot, altho' I ſcarce covered the bottom. I have alſo ſet the Tar on fire to prevent it's riſing, and dropped the Tar into the Pot by (ſeemingly) Spoonfuls, and yet notwithſtanding could not ſave the ½ Part of what is generally made with right neat Tar.

Such Commodities riſe and fall in the Price, according to the Times and Seaſons of obtaining them; for they being chiefly brought from Foreign Parts, it cannot be reaſonably expected otherwiſe, but that the Advantage will be made according to the Scarcity and Neceſſity they obſerve in others; ſo that at ſome times Tar is ſold for 20 *s.* and Pitch in proportion to that Price, as 3 to 2; whereas at other times Tar riſes in Value to 40 *s.* a Barrel, and Pitch in proportion as aforeſaid; ſo that there is 20 *s.* advanced by the Difficulty that will be always found in dealing with a Stranger, beſides the hazard that is run in the Quality of the Material, as in all likelyhood to be deprived of having neat Goods, or otherwiſe the true Juice that is diſtilled from the Pine Timber; and ſince *Virginia*, *New England*, *Newfoundland*, nay, our own Kingdom of *North Britain*, can afford us as good Tar, and from that as good Pitch, as any that is brought from the *Eaſt* Kingdoms, it is not Neceſſity that obliges us to be beholding to others for ſuch Commodities as our own Land doth abound with, but the neglecting of our own Manufactures, and encouraging Strangers in theirs.

All which and much greater Advantages may be made by this excellent Juice, were there (as Mr. *Evelyn* ſays) induſtrious and skilful Perſons imploy'd about the ſame.

I ſhall juſt inſtance what Quantity of Pitch and Tar may be expended in the Royal Navy every Year (preſuming that there may be double that Quantity expended in the Concern of our whole Kingdom of *Great Britain* and *Ireland*) from which may be plainly ſeen what Advantage is made, and Money expended to purchaſe this one Material in Ship-building and Rebuilding.

In the firſt Place I will mention how often any Ship ought to be clean'd and dreſs'd, ſo as to preſerve her Bottom, and make her uſeful.

Secondly, what Quantity of ſuch Materials may be uſed on each particular Ship at ſuch Dreſſing; and thirdly, the Number of Shipping there is to be ſo trimm'd, with the Total Expence.

Firſt then, if a Ship is employ'd in the Sea Service, ſhe ought to be clean'd and dreſs'd every 12 Months at the fartheſt, if it be poſſible; which Method of preſerving them neat and wholeſome, will not only preſerve the Health of her Men, by Lodging them warm and in good Order, but it will alſo add to the Motion of the Machine, and make her to Sail much ſwifter; but on the other hand, if the Ship is laid by and in a Harbour, then once in three Years may be ſufficient to dreſs her Bottom, but ſtill to continue the Practice of dreſſing and preſerving the Upper Work every Summer Seaſon.

Again, if a Ship is in a Cruiſing Station, as moſt Men of War under 90 Gun Ships generally are, then ſuch ought to be clean'd under Water once in Two Months at fartheſt, and at ſuch Cleaning they ought to be dried with Reed or Broom, juſt to melt in the Pitch, and harden the Plank; ſo that a little Tallow will be ſufficient to preſerve ſuch a Ship's Bottom 12 Months, and at the Expiration of that Time they ought to be new cover'd with Pitch, or Roſin and Oyl.

I ſhall therefore allow a Coat (as it's ſometimes term'd) of Pitch to every Ship in *England* (that's in the Publick Service) under a Ship of 70 Guns, once in every Year, and all the Ships from that Size to be covered once in 18 Months; alſo that every one of them ſhall be calked and dreſs'd above the Waters Edge every Year, and then the Quantity of Pitch to dreſs ſuch a Number of Ships as there is in the Publick Service, according to the Method preſcribed will be as follows.

Size.	*Tun.* Magnitude of the Ship.	*Barrels.* Number of Barrels of Pitch that will dreſs each Size	*Barrels.* Number of Barrels of Pitch that will be expended every Year for one Ship of a Sort.	*Numb.* Number of Ships there is of each Size.	*Numb.* Number of Barrels of Pitch that will be expended each Year to dreſs all the Ships.
First	1700	18	12	7	84
Second	1400	15½	10	14	140
Third	1000	10½	9	45	315
Fourth	600	8¼	8¼	63	533
Fifth	350	5½	5½	40	220
Sixth	250	2¼	2¼	24	66
			47½		1358

Memorandum, That there being 30 Fireſhips, and they being equal to the fifth Rates, the Number of Barrels of Pitch to dreſs them will be 165.

Then for Yatchs, Bomb-Veſſels and Scout-Boats, they being 34 in all, (and I allow them equal to ſixth Rates) the Number of Barrels of Pitch will be for them 93, added to 165, is 258, and adding in 1358, the Total Sum will be 1616.

Then the Number of Barrels of Pitch to dreſs a Ship of each Size every Year, will be 45 and a half, and the whole Quantity for doing it every Year will be 1616 Barrels of Pitch; then the Quantity of Pitch, which very probably is expended every Year on the Publick Ships, with what is uſed on Boats, Carpenter's Sea-Stores, and the ordinary Services of the Navy, as the Yard's Expence; alſo for pitching Planks within-ſide under Water in new built Ships, then for Timber-Hoys, Tranſports, Lighters, and the like, may reaſonably be 500 Barrels more, all which amounts to 2116 Barrels, which at 40 *s.* a Barrel, is 4232 *l.* a Year for Pitch, to which I ſhall ſubjoin the Charge of the Tar as follows.

The Uſe of Tar is more various than the Pitch, ſince at ſome times they mix Tar with Pitch, to Pay Ships Bottoms under Water, believing the Pitch by it ſelf will be too hard, and will not penetrate into the Pores of the Plank, for which Reaſon they ought to make the Plank very hot, when the Pitch is applied, alſo the Tar ought to be full hot, and alſo clear of Droſs.

However, as to the Tar, which is put amongſt Pitch to ſoften it, I have allowed it already, and therefore have nothing to conſider of but the Tar which will be requiſite to pay the Ship's Sides and Deck, which I ſhall ſet down as follows.

Size.	*Tunn.*		*Barrels.*		*Number.*		*Barrels.*	
Firſt	1700	Size and Magnitude of the Ship.	5 ½	Barrels of Tar requiſite for one Ship of a Size.	7	The Number of Ships there is of each Size.	35	The Number of Barrels of Tar which is expended every Year on the Ships mention'd.
Second	1400		4 ½		14		63	
Third	1000		2 ¾		45		123	
Fourth	600		2 ¼		63		126	
Fifth	350		1 ¾		40		70	
Sixth	250		1 ¼		24		30	
							447	

The Fireſhips are thirty, which I allow equal to a fifth ſized Ship, ſo the Barrels of Tar for them will be	52
Then for the Yatchs, Bomb-Veſſels and Scout-Boats	40
Carpenter's and Boatſwain's Stores in one Year may be	300
For the Yards Uſe, and Tranſports, Lighters and Hoys	500
	892

Then the Total Sum of Tar expended in one Year, will be 1339 Barrels, at 1 *l.* 6 *s.* 3 *d.* a Barrel, is 1722 *l.* which put to 4232 *l.* the Value of the Pitch, it makes 5954 *l.*

Now it's very probable that there may be twice ſuch a Quantity of Pitch and Tar expended throughout our Kingdoms in private Affairs, ſo that the Sum to purchaſe it will be 17862 *l.* every Year, and ſuch Commodities being generally obtain'd with Bullion, it is ſo much the worſe for us; for could it be purchaſed for Goods of our own Growth, it would be little otherwiſe than Barter, to the Encouragement of our Manufactures, as well as to the Encouragement of Strangers.

Whether my Computation on this Head is over or under the real Quantity of ſuch Goods that is yearly imported into theſe Kingdoms, it matters not; I ſhall therefore refer the nice Account and Knowledge of what is brought over to thoſe that are placed purely to take Account, and only make theſe Intimations, to ſhew what might be advanced in his Majeſty's Dominions, and that our Countrymen may not be ſtreightened for the want of ſuch Goods, if the Fereigners ſhould hinder our Traffick: And ſo I ſuſpend this Diſcourſe, believing that I have laid down all the Rules, (or indeed what is moſt material) in Calking any Ship, alſo in paying, ſlubing, or dirting of her with Pitch, Tar, and the like, which I preſume in moſt Ships are ſcraped off again, except that which lyes in the Seams to cover the Oakham; and after ſuch cleanſing, it's general for new Ships to be adorn'd and beautify'd with Paint. To which particular Conſideration I ſhall proceed and conſider of it in the next Place.

OF

Painting SHIP-WORK.

BEFORE I begin on this Subject, I ſhall give a few neceſſary Cautions which ought to be minded in fitting and preparing the Parts that are deſigned to be Painted, otherwiſe your Paint, (which undeniably is a very good Preſervative, if rightly apply'd) will be of little Uſe or Service.

And firſt, you are to take very particular Notice, that the Timber which is to be painted be full dry, and well ſeaſon'd, otherwiſe the Paint will not ſoke or penetrate into the Pores of the Timber; for the Pores being fill'd with the Sap or Water, the Oyl and other Ingredients, (which are drawn or drove in by the Heat of the Sun in dry and well ſeaſon'd Timber,) will in a ſmall Time peel off again, and ſo become Uſeleſs.

And this ſo very material and neceſſary Caution well minded, might put us in Mind of that pernicious and diſorderly Cuſtom, that's upheld amongſt us, and generally practiſed; which is in felling our principal Timber at an unſeaſonable Time in the Year, when the Sap is up in the Body of the Tree, and alſo in the Branches.

And this deſtructive Faculty is really advanced through a wrong Notion, that the Bark of Trees cannot be as well taken off when the Trees are ſtanding, as it can afterwards, when in Truth, and in Reaſon there will be found but very little Difference, or none at all, if rightly conſider'd; ſince ſome Part of the Bark on the under Side muſt be left on at ſtripping the Tree after it is cut down, and that I preſume might pay the Charge of that little Trouble which would be in raiſing a Ladder, or making a ſmall moveable Scaffold; but was the Charge one Day's Work for two Men, at 18 *d.* a Day Difference, or let it be 18 *d.* in every Load of Timber Difference, I am poſitive that every Load of Timber that is ſeaſonably cut would be of double Value to that which is fell'd at a wrong Time of the Year; and that in ſome Timber would be 3 or 4 Pound in every Load, or 50 Foot of Timber, ſince the Duration would be thrice as long as the Timber that is cut in ſtripping Time, as I have more fully explain'd in another Place of this Volume.

The ſecond Caution is, That ſpecial Regard ought to be had in Painting Ships at their fitting and various Reparations, ſince ſuch Viciſſitudes ofteneſt happen to Publick Ships in the Winter Seaſon, and then according to the Time it is obſerved to be very uncertain, wet and dirty Weather; ſince our Men of War, which in the Summer Seaſon are more or leſs upon the Cruiſe, and hunting after the Enemy, are more at leiſure in the Winter, when ſuch Roving Times are paſt, and the Service not ſo much requiring ſuch a large Number of Ships in Action; and then the greater Part may all, by Turns, be ordered in to clean and fit againſt the next Summer Service.

You may obſerve, that the Charge of Painting a Ship of the biggeſt Magnitude meaſuring 1700 or 1800 Tuns, is upwards of 48 Pound; the Charge of the ſecond Size, being 1400 Tuns, is upwards of 40 Pound; the third Size of 1000 Tuns is upwards of 28 Pound; the fourth Size of 600 Tuns, upwards of 20 Pound; the fifth Size of 350 Tuns, upwards of 12 Pound, and the ſixth of 250 Tuns, upwards of 5 Pound. Now if the ſmalleſt of theſe

Sums that I have mentioned was to be our own Loſs, I am poſitive moſt Men would endeavour by all poſſible Caution to prevent the Miſcarriage, I ſhall therefore proceed to give ſome neceſſary Directions how ſuch Faults may be prevented, that have been generally commited in refreſhing the Paint of the Weather Work on Shipping at the Winter, and then conſider and give my Opinion of the Neceſſity there is to Paint Ships at Set Times, tho' the Weather be really contrary to the drying or hardening of the Work.

When I was employ'd to meaſure the Painter's Work in Her Majeſty's Yard at *Portſmouth*, I have often obſerv'd, that rather than the Painter would loſe the painting of a Ship, he would actually paint the Work, when it rain'd upon the Part that his Bruſh mov'd on. As to the Appearance of Rain, or to have all imaginable Symptoms of dirty Weather, the Painter regarded that but little, and would proceed; but as to his Indulgence, or who gave him ſuch a Toleration, I know not, but ſhall refer my Reader to gueſs when I come to explain the Nature of the Painter's Contract, and who is generally the Director in ſuch Caſes.

Nay, ſomewhat farther I ſhall mention, that I have often obſerved the Paint to be waſhed off again with the Rain, and become of little Account: Nay, what with the Dirt that was on before the Paint began, and the Wet that came after, the Ship has been ſo ſtrangely beſmear'd, that ſhe really look'd unſeemly, and much worſe for Ornament, than if ſhe had not been touch'd with a Painter's Bruſh; when upon the other Hand, had the Ship been well clean'd, and all the dirty Paint ſcrap'd off, and the Plank or Board near bare, then Painting would be highly Serviceable, and the Charge of doing it paid treble, by the well tempering and uſing the Material.

However, in caſe there is Neceſſity to paint a Ship in the Winter Seaſon, and the Caſe cannot be otherwiſe bore with, but ſuch a Faculty muſt be proſecuted in rainy dirty Weather, then let the Ship be cover'd with Sail-Cloth, which would be done for a very ſlender Charge, in Conſideration of that vaſt Difference which will be between Paint that is well laid on, and harden'd in, and ſuch that is only dawb'd on to increaſe a Charge.

But in the next Place I will mention what Neceſſity there is in painting Ships at Set Times, and by a Maſter Painter and his Crew, that are kept purely for that purpoſe.

I ſay, provided a Ship was going a long Voyage, as to the *Weſt Indies* or *Streights* of *Gibraltar*, or into ſome other hot ſcorching Countrys, where undeniably will be found more Neceſſity to paint, and fill the Chaps that are cauſed by the Sun's exceſſive Heat, than can be in our Country, or when Ships are only cruiſing in the Channel; and in ſuch hot Climates perhaps a Ship may be continued two or three Years, and yet never painted, neither a Maſter Painter nor any of his Crew to attend the engroſſing of Trade, or exerting their Faculties to make out a large Bill againſt the End of the Quarter.

The *Hollanders*, and ſeveral other Country Ships, carry Paint with them, (and as Mr. *Evelyn* recommends in *Sylva*) make Uſe of it themſelves by ſome one or other belonging to the Ship's Crew; nay, ſeveral of our Merchant-ſhips do the ſame, they paint when Neceſſity requires, and when the Paint is likely to do Service to the Part they apply it to, as well for Ornament, as for preſerving the Stuff they cover; and ſuch ſeaſonable Painting will be found extreamly Wholeſome and Refreſhing both to the Ship, and alſo to the Ship's Crew; preſerving the Timber; adding a greater Luſtre, than what three times Painting will do at unſeaſonable Times.

The Accommodations within-ſide ought alſo to be done in very dry Weather, when the Oyl will ſoak in, and not cauſe dampneſs, from which a Sickneſs may flow, and by Caution may be prevented. But I proceed to ſhew you the Nature of the Maſter Painter's Contract, which I copy'd from the Maſter Painter in the Year $170\frac{1}{2}$. when I meaſured the Work for the Service; not that I deſign to give you the Preamble that is made in Form by the Clerks, but only the Heads of all the Prices for Painting the Ship within Board and without Board, either by the Piece, or by the Superficial Yard, or 3 Foot Square; alſo how the Painter is bound and obliged to comply.

This Copy was taken from Madam Harriſon's Contract in 170½. when ſhe officiated the Painting of her Majeſty's Ships refitting at *Portſmouth*. The Contract bore Date the 18th of *December* 1695.

Firſt for new Works, and three times Priming and once Painting a fair Colour, the Head, the Stern and the two Galleries. *Memorandum*, Theſe Prices were ſet before the Carved Work was reduced, or taken from the Publick Ships.

Size.	Tunnage.	For Painting the Head, Stern and Galleries.						For each Carved Port.						For each Red Port within-ſide.					
		New.			Refreſhing.			New.			Refreſhed			New.			Refreſhed.		
		l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Firſt	1700	17	0	0	8	0	0	0	1	3	0	0	7	0	0	6½	0	0	3
Second	1400	14	0	0	7	0	0	0	1	1	0	0	7	0	0	6	0	0	3
Third	1000	9	0	0	4	10	0	0	0	8	0	0	4	0	0	6	0	0	3
Fourth	600	5	0	0	2	10	0	0	0	7	0	0	3¼	0	0	6	0	0	3
Fifth	350	3	5	0	1	12	6	0	0	5	0	0	2½	0	0	5	0	0	2¾
Sixth	250	1	10	0	0	17	6	0	0	3	0	0	1½	0	0	3½	0	0	2¼

Size.	Tunnage.	For every Yard of Rail Running Meaſure.						For every Bulkhead Bracket.					
		New.			Refreſhed			New.			Refreſhed.		
		l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Firſt	1700	0	0	2¼	0	0	1	0	1	2	0	0	6½
Second	1400	0	0	2¼	0	0	1	0	1	1	0	0	6
Third	1000	0	0	1¾	0	0	0$\frac{2}{8}$	0	0	8½	0	0	3½
Fourth	600	0	0	1¼	0	0	0⅝	0	0	6½	0	0	3
Fifth	350	0	0	1	0	0	0½	0	0	5	0	0	2½
Sixth	250	0	0	0¾	0	9	0⅜	0	0	3¼	0	0	1¾

For new Painting of all Frized Work (which in this Place is meant of all Carved Work that is not otherwiſe ſpecified) either in Ship or Boat Work, meaſuring the ſame Mathematically with a Ruler, and not with a Line; the Allowance is for every Square Yard 14 Pence, and for Refreſhing the ſame the Allowance is 7 *d.* a Yard.

For three times Priming and once Painting either Stone or Wood Colour, Graining or Reveling the ſame, for the Repairing of ſuch Ships as are already done, intimating that ſuch a Trivial Charge is forbid, ſince all new Work for the future is directed to be done with Plain Colours; the Revel'd Work is valued at 9 *d. per* Yard.

For three times Priming and once Painting, all uſual plain Colours, Green excepted, at 7 *d.* ½ *per* Yard

So that there is 1 *d* ½ Difference between the flouriſh'd Work and the plain in every Yard.

For three times Priming and once Painting all flat Work, the black Work under the Frizes included, at 7 *d. per* Yard.

For Priming and Painting all Barges and Pinnaces, and Jolly-boats; the Upper Strakes, Rails and Gunnels, Fore and Aft; the Stern, Rudder, and Tiller; the Stern Sheets, Thwarts, and Gang-Boards; the Timbers and the Work within-board down to the Floor, and Ceiling of Barges for Flag Ships; but the Water Boats only to Paint the Upper Strakes, Stern Rails, and Gunnels Fore and Aft, to Paint the Timber Heads down to the Twharts; alſo the Benches, Thwarts and Stern.

The Value for Painting each, one with another, once Painting is 4 *s.* twice 7 *s.* and for three times Painting 9 *s.* For Refreſhing all plain Colours, Green excepted, 2 *d.* ½ *per* Yard, and for Refreſhing all Grain'd and Revell'd Work, if any is done, 4 *d.* ½ *per* Yard.

For Painting Saſh Lights and Window Bars, 9 *d. per* Yard Square. For Painting of Poop Lanterns, for every Foot in Height, for once Painting 7 *d.* and twice Painting 11 *d.*

For Barge Oars from 14 to 19 Foot long, once Painting 5 *d.* twice 6 *d.* ½, thrice 8 *d.* ½ each.

And farther, if at any time there ſhall be Directions given for the doing thereof, for Painting Canvas either Old or New, for Windows, and the like, the Painter is to be allowed the ſame Price with other plain Colours.

Here follows an Addition to the Painter's Contract, which I alſo copy'd out of a Contract made between the Principal Officers and Commiſſioners of his Majeſty's Navy and the ſaid Madam *Harriſon*, dated the 19th of *July*, 1698.

That at the Painter's Charge, ſeaſonably ſhall be done to her Majeſty's Ships and Houſes the ſeveral Works hereafter mentioned; that is to ſay, for to ſerve in Colours as ſhall be demanded by the Maſter Shipwright of her Majeſty's Yard at *Portſmouth.*

And if it ſhall happen for a Ship to ſail before her Painting Works be compleated, the Painter is to be allow'd for the firſt Priming 2 *d.* ½ *per* Yard, and for the finiſhing Colour 2 *d.* ½ *per* Yard; and for the ſecond Priming 1 *d.* ½ *per* Yard; ſo that if he cannot lay on the third Priming, he is only to be abated 1 *d. per* Yard, out of the 7 *d.* ½ Penny, his common Allowance: Alſo for Graining and Revelling all ſorts of Stone and Timber Colour, referring to the Caſes aforeſaid; if the Painter finiſhes his Work upon the firſt Colour, he is to have 6 *d.* ¾ *per* Yard, and if he Primes it twice, and finiſhes upon the ſecond Priming, 8 *d. per* Yard.

For Window Lights in Houſes within-ſide or without ſide, once doing to have 1 *d.* ½ Penny *per* Yard, twice doing at 3 *d.* and thrice doing at 4 *d. per* Yard.

For Painting Caſements he is to have 2 *d.* ½ Penny for each time.

To provide Red Colour for the Maſt-makers Uſe to mark Maſts with, at 4 *d. per* Pound.

To provide Whiting for the Maſons, to White Houſe with, at 3 *d. per* Pound.

To provide Putty on ſeveral Occaſions, at 5 *d. per* Pound.

For marking of Doors, Guns, Talleys, *&c.* with Letters or Figures, at 3 *d. per* Dozen Letters.

For Painting of Boats a bright Port red Colour, at 5 *s.* each.

For Painting of Oars, and Waveing them, at 6 *d.* each.

For Painting of Leather Buckets, at 4 *d.* each.

For Gilding of Carved Work 4 *s.* 5 *d. per* Yard Square, and for Gilding of Flat Work 3 *s.* and to meaſure as before recited.

And every Part of the ſaid Work ſhall be performed with good Colours, well Ground, and laid with Linſeed Oyl, and the Red Colour, Whiting, and Putty, ſhall in every reſpect be fitting for the Service.

And by way of Caution, I obſerved an Order directed, that no Ship-work within-board ſhall be Refreſhed, except at the Rebuilding, or at very great Repairs. The Weather-work to be done once in Twelve-Months, if need require, for the Preſervation of the Carved and the Quick-work.

I ſhall proceed now to make ſome uſeful Obſervations, and ſhew how theſe Allowances agree with Reaſon, and the Superficial Content of the Species to be painted; but firſt ſhall ſet down the Meaſurement of one particular Ship of the ſix Sizes before mention'd, which will make my Obſervations the more Conſpicuous.

The Meaſurement of the firſt Sized Ship of 1700 Tuns will be as follows.

The Plain-Work without Board and Decks.

				l.	s.	d.
All the Weather Work within and without	containing	840	at 7 d. ½ per Yard is	150	10	5
The Lower Gun Deck		2397				
The Middle Gun-Deck		1580				
The Imboſſed Rails on the Outſide, one with another, at 2 d. ½ per Yard, containing 530 Yards				4	19	4½
Red Ports for the Gun holes, 100 at 6 d. ½ each, leaving out the Carved Ports				2	14	6
For Painting the Head, Stern, and 2 Galleries, new as aforeſaid				16	00	0

All the Work within-ſide out of the Weather.

	Yards		l.	s.	d.
For Painting the Great Cabbin, it containing	330	In all it is 1565 Yards at 9 d. per Yard, which amounts to	58	13	3
For the Lower Coach	270				
For the Upper Cabbin and Coach	280				
For the Gunners Cabbin	65				
For the Boatſwain and Carpenter's Cabbin	75				
For 2 Cabbins at the Bulk-head of the Lower Coach	75				
For the Ward-Room	250				
For the Surgeon and Purſers Cabbin	75				
For the Lieutenant's Cabbin at the Bulk-head of the Gun-Room	45				
For three other Cabbins for the Lieutenants and the Chaplain	100				
Total	1565				
Saſh Frames 660 Feet at 1 d. per Foot			2	15	0
Poop Lanterns three, at 10 d. per Foot			1	06	5½
Canvas 120 Yards at 7 d. ½ per Yard			3	15	0
Boats three, at 9 s. each Boat			1	07	0
Oars 50, at 8 d. ½ each Oar.			1	15	5
Total			244	16	5

The whole Sum for Painting ſuch a Ship, her Boats, and all what belongs to her Furniture, new off from the Stocks, as it's term'd, will be 244 l. 10 s. 5 d.

Memorandums of the Dimenſions of her Ports.			Ft.	Inch.
Ports	Lower	Fore and Aft	3	7½
		Up and Down	2	8
	Middle	Fore and Aft	3	2
		Up and Down	2	7
	Upper	Fore and Aft	2	9
		Up and Down	2	6

Then the Area in the Medium will be 8 Ft. $\frac{1}{10}$, which is $\frac{9}{10}$ of a Ft. leſs than 1 Yard Square, and ſo ſuch a Ship's Ports may be reckon'd, one Port with another.

The Sheer Rail is 7 Inches up and down; ſo that the Content of the Rail in Square Yards will be 162 Yards, meaſured as the half of a Cylinder, making the Depth the Diameter of ſuch a Cylinder; and alſo I take the biggeſt Rail for the Meaſure of all which will be advantagious to the Painter; and for every Square Yard I allow 7 d. ½, and after that Computation the Rail will come to 5 l. 1 s. 3 d. which is 1 s. 10 d. ½ more than the common Allowance.

The Poop Lanterns will be one of 9 Ft. 3 In. and two of 7 Ft. 8 Inches, which put together is 24 Ft. 7 Inches.

I proceed now to the Meaſure of the Painting-Work of the ſecond ſized Ship of 1400 Tuns, which will be as follows.

The Plain-Work without Board, and the Decks.

			l.	s.	d.
All the Weather Work within and without — containing	703	at 7 *d.* $\frac{1}{2}$ per Yard is	143	17	6
The lower Gun-Deck	2198				
Middle Gun-Deck —	1712				
The Imboſſed Rail on the Outſide one with another at 2 *d.* $\frac{1}{4}$ per Yard, containing 505 Yards — —			4	14	8$\frac{1}{4}$
Red Ports for the Gun-holes 90, at 6 *d.* $\frac{1}{2}$ each, leaving out the Carved Ports — — — —			2	08	9
For Painting the Head, Stern and 2 Galleries, new as aforeſaid			14	00	0

All the Work within-ſide out of the Weather.

	Yards.				
For Painting the Great Cabbin, it containing	320				
For the lower Coach — —	262				
For the upper Cabbin and Coach —	278				
For the Gunner's Cabbin — —	60				
For the Boatſwain and Carpenter's Cabbin	70	In all it is 1485 Yards at 9 *d.* per Yard, which amounts to	55	13	9
For 2 Cabbins at the Buſk-head of the lower Coach — — —	70				
For the Ward Room — —	228				
For the Surgeon and Purſer's Cabbin —	65				
For the Lieutenant's Cabbin at the Bulk-head of the Gun Room — —	32				
For the 3 other Lieutenants Cabbin, and for the Chaplain's Cabbin — —	100				
Total is	1485				
Saſh Frame 560 Foot at 1 *d.* per Foot — — —			2	06	7
Poop Lanterns three, at 10 *d.* per Foot for twice Painting —			0	17	9$\frac{1}{2}$
Canvaſs 100 Yards at 7 *d.* $\frac{1}{2}$ per Yard is — —			3	02	6
Boats three at 9 *s.* each Boat — — —			1	07	0
Oars 50, at 8 *d.* $\frac{1}{2}$ each Oar — — —			1	14	5
		Total	230	02	11$\frac{3}{4}$

The whole Sum for Painting ſuch a Ship, her Boats, and all what belongs to her Furniture, new from the Stocks, will be 230 *l.* 2 *s.* 11 $\frac{3}{4}$.

Memorandum of the Dimenſions of her Ports,

Ports.			Feet.	Inch.
	Lower	Up and Down	2	7
		Fore and Aft	3	6
	Middle	Fore and Aft	3	0$\frac{1}{2}$
		Up and Down	2	6
	Upper	Fore and Aft	2	7
		Up and Down	2	4

Then the Area in the Medium will be 7 Ft. $\frac{6}{16}$, which is 1 Ft. $\frac{4}{16}$ ſhort of a Square Yard, and ſo ſuch a Ship's Ports may be reckon'd one with another.

The ſheer Rail is 6 Inches and a half up and down, that the Content of the Rail in Square Yards will be 141 Yards, meaſured as a Cylinder, by making the Depth the Diameter of the Cylinder, and continuing the Cuſtom of making the biggeſt Rail the Meaſure for all, then allowing 7 *d.* $\frac{1}{2}$ for every Square Yard, the Sum will be 4 *l.* 8 *s.* 1 *d.* but the Sum as Cuſtom being 4 *l.* 14 *s.* 8 *d.* $\frac{1}{4}$, the Allowance for every Square Yard is 8 *d.* and alſo making the biggeſt Rail the Gauge.

The Poop-Lanterns will be one of 8 Ft. and a half long and 2 of 6 Ft. $\frac{7}{12}$, which put together is 21 Foot 4 Inches.

I proceed now to the Meaſure of the third ſized Ship of 1000 Tuns, which will be as follows.

The Plain Work without Board, *&c.*

	l.	*s.*	*d.*
All the Weather Work within ſide and without the Decks in theſe Ships are not Painted, containing 579 Yard at 7 *d.* $\frac{1}{2}$ per Yard is —— —— —— —— ——	16	17	9
The Imboſſed Rail on the Outſide one with another at 1 *d.* $\frac{3}{4}$ per Yard, containing 400 Yards —— —— ——	2	18	1
Red Ports for Gun-holes 70, at 6 *d.* $\frac{1}{2}$ each, leaving out the Carved Ports —— —— —— ——	1	17	11
For Painting the Head, Stern and Galleries, new as aforeſaid	9	00	0

All the Work within-ſide out of the Weather.

	Yards.		*l.*	*s.*	*d.*
For Painting the Great Cabbin, it containing	289				
The lower Coach in this Ship is called a Steerage —— —— —— ——	260	In all it is 963 Yards at 9 *d.* per Yard, which amounts to	36	13	6
For the upper Cabbin and Coach ——	200				
The Gunners Cabbin —— ——	40				
The Boatſwain and Carpenter's Cabbin ——	55				
Two Cabbins, at the Bulkhead of the Steerage —— —— —— ——	55				
For the Surgeon and Purſer's Cabbin ——	54				
Lieutenants Cabbin at the Bulk-head of the Gun-Room —— —— ——	25				
	963				
Saſh Frame 350 Foot, at 1 *d.* per Foot is —— ——			1	09	2
Poop Lanterns 3, at 10 *d.* per Foot for twice Painting ——			0	13	4
Canvas 80 Yards, at 7 *d.* $\frac{1}{2}$ per Yard is —— —— ——			2	05	2
Boats 2, at 9 *s.* each Boat —— —— —— ——			0	18	0
Oars 35, at 8 *d.* $\frac{1}{2}$ each Oar —— —— —— —— ——			1	04	9 $\frac{1}{2}$
			73	17	8 $\frac{1}{2}$

The whole Sum for Painting ſuch a Ship, her Boats and all what belongs to her Furniture, new off from the Stocks, will be 73 *l.* 17 *s.* 8 *d.* $\frac{1}{2}$.

				Feet.	*Inch.*
Memorandums of the Dimenſions of the Ports	Ports	Lower	Fore and Aft	3	4
			Up and Down	2	7
		Upper	Fore and Aft	2	7
			Up and Down	2	4

Then the Area in the Medium of her Ports will be 7 Ft. $\frac{3}{10}$, which is 1 Foot $\frac{7}{10}$ leſs than a Square Yard, and ſo ſuch a Ship's Ports may be reckon'd one Port with another.

The Sheer Rail is 6 Inches up and down, that the Content of the Rail in Square Yards is 106 Yards meaſur'd as a Cylinder, by making the Depth of the Rail the Diameter of ſuch a Cylinder, and continuing the Cuſtom of making the biggeſt Rail the Meaſure for all. Then allowing 7 *d.* $\frac{1}{2}$ for Painting every Square Yard, the Sum will be 3 *l.* 6 *s.* 3 *d.* but the Sum as Cuſtom is but 2 *l.* 18 *s.* 1 *d.* ſo that allowing for Painting, every Square Yard is but 6 *d.* $\frac{1}{2}$ per Yard, and allowing the biggeſt Rail for the Gauge.

The Poop Lanterns will be one of 6 Ft. long, and 2 of 5 Ft. which together is 16 Ft.

I proceed now to the Meaſure of the fourth ſized Ship of 600 Tuns, which will be as follows.

The Plain Work without Board, *&c.*

	l.	*s.*	*d.*
All the Weather Work within and without, the Decks in theſe Ships not being Painted, containing 450 Yards at 7 *d.* ½ per Yard is	14	01	0
The Imboſſed Rail on the Outſide one with another at 1 *d.* ¼ per Yard, containing 350 Yards	1	16	5
Red Ports for Gun-holes 50, at 6 *d.* each, leaving out the Carved Ports	1	05	0
For Painting the Head, Stern and Galleries, new as aforeſaid	5	00	0

All the Work within-ſide out of the Weather.

	Yards.				
For Painting the Great Cabbin, it containing	210				
For the Steerage	165	In all it is			
For the Round-Houſe, or 2 Cabbins in that Room	62	652 Yards			
The Gunner's Cabbin	37	at 9 *d.* per			
The Boatſwain and Carpenter's Cabbin	53	Yard, which			
For 2 Cabbins at the Bulkhead of the Steerage	53	amounts to	24	09	0
For the Surgeon and Purſer's Cabbin	52				
Lieutenants Cabbin at the Bulk-head of the Gun-Room	25				
Total	652				
Saſh Frame 152 Foot, at 1 *d.* per Foot is			0	12	8
Poop Lantern 1, at 10 *d.* per Foot for twice Painting			0	04	7
Canvas 63 Yards, at 7 *d.* ½ per Yard is			2	04	6
Boats 2, at 9 *s.* each Boat			0	18	0
Oars 35, at 8 *d.* ½ each Oar			1	04	9
			55	15	11

The whole Sum for Painting ſuch a Ship, her Boats and all what belongs to her Furniture, new off from the Stocks, will be 55 *l.* 15 *s.* 11 *d.*

Memorandums of the Dimenſions of her Ports				Feet.	Inch.
	Ports	Lower	Up and Down	2	5
			Fore and Aft	2	10
		Upper	Fore and Aft	2	4½
			Up and Down	2	2

Then the Area of theſe Ports in the Medium will be 6 Ft. or ⅔ of one Square Yard, and ſo ſuch a Ship's Ports may be reckon'd one Port with another.

The Sheer Rail is 5 Inches ¼ up and down, ſo that the Content of the Rails in Square Yards is 83 Yards, meaſur'd as a Cylinder, by making the Depth of the Rail the Diameter of ſuch a Cylinder, and continuing the Cuſtom of making the biggeſt Rail the Meaſure for all. Then allowing 7 *d.* ½ for Painting every Square Yard, the Sum will be 2 *l.* 11 *s.* 10 *d.* ½, but the Sum as Cuſtom is but 1 *l.* 16 *s.* 5 *d.* ſo that the Allowance for Painting, every Square Yard is but 5 *d.* $\frac{2}{10}$ per Yard, and allowing the biggeſt Rail for the Gauge.

The Poop Lantern will be but one of 5 Ft. ¼ long.

I proceed now to the Meaſure of the fifth ſized Ships Painting, (whoſe Magnitude is 350 Tuns) which will be as follows.

The Plain-Work without Board, *&c.*

	l.	*s.*	*d.*
All the Weather Work within and without, the Decks in this Ship, not being Painted, containing 280 Yards at 7 *d.* ½ per Yard is	7	19	10
The Imboſſed Rail on the Outſide one with another at 1 *d.* per Yard, containing 270 Yards	1	02	6
Red Ports for the Gun-holes 36, at 5 *d.* each, leaving out the Carved Ports	0	15	10
For Painting the Head, Stern and Galleries, new as aforeſaid	3	05	0

All the Work within-ſide out of the Weather.

	Yards.		*l.*	*s.*	*d.*
For Painting the Great Cabbin, it containing	150	In all it is 477 Yards at 9 *d.* per Yard, which amounts to	17	17	9
For the Steerage	120				
For 2 Cabbins on the Quarter-Deck	44				
For the Gunner's Cabbin	23				
For the Boatſwain and Carpenter's Cabbin	40				
For 2 Cabbins at the Bulk-head of the Steerage	40				
For the Surgeon and Purſer's Cabbin	40				
For one Cabbin at the Bulk-head of the Gun-Room	20				
Total is	477				

	l.	*s.*	*d.*
Saſh Frame 70 Foot at 1 *d.* per Foot	0	05	10
Poop Lantern one, at 10 *d.* per Foot for twice Painting	0	03	9
Canvaſs 30 Yards at 7 *d.* ½ per Yard is	2	18	9
Boats two at 9 *s.* each Boat	0	18	0
Oars 30, at 8 *d.* ½ each Oar	1	01	3
Total	36	08	5

The whole Sum for Painting ſuch a Ship, her Boats, and all what belongs to her Furniture, new from the Stocks, will be 36 *l.* 8 *s.* 5 *d.*

Memorandum of the Dimenſions of her Ports,			*Feet.*	*Inch.*
Ports.	Lower	Fore and Aft	2	7 ½
		Up and Down	2	3
	Upper	Fore and Aft	2	4 ½
		Up and Down	2	0

Then the Area of theſe Ports in the Medium will be 5 Ft. $\frac{35}{144}$, near $\frac{2}{3}$ of a Square Yard, and ſo ſuch a Ship's Ports may be reckon'd to be one Port with another.

The ſheer Rail is 5 Inches up and down, that the Content of the Rails in Square Yards will be 57 Yards, meaſured as a Cylinder, by making the Depth of the Rail the Diameter of ſuch Cylinder, and continuing the Cuſtom of making the biggeſt Rail the Meaſure for all, then allowing 7 *d.* ½ per Yard for Painting every Square Yard, the Sum will be 1 *l.* 15 *s.* 7 *d.* ½. but the Sum as Cuſtom is 1 *l.* 2 *s.* 6 *d.* ſo that the Allowance for Painting every Square Yard is 4 *d.* ¾ per Yard, and allowing the biggeſt Rail to be the Gauge.

The Poop-Lantern is but one of 4 Ft. and a half long

I proceed now to the Meaſure of the ſixth Sized Ships Painting, (whoſe Magnitude is 250 Tuns) which will be as follows.

The Plain-Work without Board, *&c.*

	l.	*s.*	*d.*
All the Weather Work within and without, the Decks in this Ship not being Painted, containing 138 Yards at 7 *d.* ½ per Yard is	4	06	3¾
The Imboſſed Rails on the Outſide, one with another, at 3 Farthings a Yard, containing 135 Yards	0	08	5
Red Ports for the Gun-holes 24, at 3 *d.* ½ each, leaving out the Carved Ports	0	07	0
For Painting the Head, Stern, and Galleries, new as aforeſaid	1	09	0

All the Work within-ſide out of the Weather.

	Yards				
For Painting the Great Cabbin, it containing	103				
For the Steerage	85	In all it is			
For the Gunners Cabbin	17	287 Yards			
For the Boatſwain and Carpenter's Cabbin	28	at 9 *d.* per			
For the Surgeon and Purſers Cabbin	28	Yard, which			
For the Maſter's and Lieutenant's Cabbin	34	amounts to	11	01	3
Total	287				

Saſh Frames 35 Feet at 1 *d.* per Foot	0	02	11
Poop Lantern one, at 10 *d.* per Foot	0	02	6
Canvas 15 Yards at 7 *d.* ½ per Yard	0	09	4
Boats one, at 9 *s.*	0	09	0
Oars 16, at 8 *d.* ½ each Oar.	0	11	4
Total	24	07	0¾

The whole Sum for Painting ſuch a Ship, her Boats, and all what belongs to her Furniture, new off from the Stocks, will be 24 *l.* 7 *s.* 0 *d.* ¾.

			Ft.	*Inch.*
Memorandums of the Dimenſions of her Ports	Ports	Fore and Aft	2	5
		Up and Down	2	0

Then the Area of theſe Parts will be 4 Ft. $\frac{2}{10}$, which is near ½ a Yard Square, and ſo theſe Ports may be reckon'd to be.

The Sheer Rail is 4 Inches and a half deep; ſo that the Content of the Superficies in Square Yards will be 26 Yards, meaſured as a Cylinder, by making the Depth of the Rail the Diameter of ſuch a Cylinder; and continuing the Cuſtom of making the Meaſure of the biggeſt Rail ſerve for all; then allowing 7 *d* ½ for Painting every Square Yard, they ſo meaſure, the Sum will be 16 *s.* 3 *d.* but the Sum as Cuſtom is 8 *s.* 5 d. ſo that the Allowance for Painting every Square Yard is but 3 *d.* and $\frac{88}{100}$, not quite 4 *d.* per Yard, or little above half Price.

The Poop Lantern is but one of 3 Ft. long.

And now I ſhall proceed to make ſome uſeful Obſervations of the Prices and Meaſures in Ship-Painting; and alſo ſhall make ſome general Calculations for ſuiting and making the Prices agreeable, according as the Magnitudes of the Ships, and Superficial Content of their ſeveral and reſpective Parts are one to another.

And in the firſt Place it's ſaid, that for painting Saſh Frames, (without Exception to their various Figure) the Value is 1 *d.* per Foot, or 9 *d.* per Yard Square, ſo that there is allowed the whole Superficial Area of the Glaſs, as well as the Wood, for a Pretence of an over Trouble, or ſome unuſual Labour, to prevent the Pains from being ſlabber'd, which, in my Opinion, ought as well to be allow'd in Painting the Rails on the Sides, or ſeveral other projecting Parts in a Ship, ſo that this Branch would be much better adjuſted by exactly Meaſuring the Wood according to its different Size, ſince the Work will be more or leſs, according to the Variety of its Dimenſions, and bigneſs of the Saſh Pains; as for Inſtance, let one ſort of Saſh Glaſs be one Foot Square, every Pain or Quarry, and the other Sort but 6 Inches Square accordingly; then let the Framing in the biggeſt Glaſs be 1 Inch and a half Square, and if it is made of ſuitable Strength in Proportion to the different Lengths, between 12 Inches and 6 Inches; then the Frames of the ſmall Glaſs will be but 1 Inch and $\frac{6}{10}$ Parts of an Inch, and the Superficial Area of the biggeſt Frame, according to a Proportion drawn from a direct Cylinder will be 2 Inches and $\frac{35}{100}$; and according to the ſame Proportion in the leaſt it will be 1 Inch and $\frac{65}{100}$, ſo that the whole Superficies contain'd in the yard of large Glaſs will be 4 Foot and $\frac{7}{10}$, and in the ſmall Glaſs it will be 5 Foot and $\frac{74}{100}$, the Difference in the Painting will be 1 Foot Square in every 9 Foot, or a Square Superficial Yard of Work, and therefore beſides allowing the Painter 7, 8 or 9 *d.* for every half Yard of Painting on the Superficies, according to the Variety of the Prices your plain Colour is allowed at, my former Hints will be again verified, that one Ship's Property will moſt certainly be loſt to make up the Property or Advantage of the other, and of which I ſhall proceed to calculate ſome Tables, to adjuſt that Part in every Particular.

Inch. The Square of the Saſh Pains, or Quarrys, in Inches.	*Inch.* The Side or Diameter of the Wood in each Frame in Inches and Parts.	*Inch* The Superficial Area of one Pain or Quarry of Glaſs, according to the Variety of Size in each.	*Inch.* The whole Circumference of the Wood in Inches and Parts.	*Inch.* The half of the Circumference of the Wood in Inches and Parts.	*Feet.* The Superficial Area that is contain'd in the Painting-Work, according to the Variety of the Size in Feet and Parts of Feet.
9	1 $\frac{1}{16}$	87	4 $\frac{1}{10}$	2 $\frac{1}{20}$	5 $\frac{22}{100}$
10	1 $\frac{3}{8}$	100	4 $\frac{3}{10}$	2 $\frac{3}{20}$	4 $\frac{35}{100}$
11	1 $\frac{7}{16}$	121	4 $\frac{5}{10}$	2 $\frac{5}{20}$	4 [illegible]
12	1 $\frac{1}{2}$	144	4 $\frac{7}{10}$	2 $\frac{7}{20}$	4 $\frac{7}{10}$
13	1 $\frac{9}{16}$	169	4 $\frac{9}{10}$	2 $\frac{9}{20}$	3 $\frac{16}{100}$
14	1 $\frac{5}{8}$	196	5	2 $\frac{1}{2}$	3 $\frac{25}{100}$
15	1 $\frac{11}{16}$	225	5 $\frac{3}{10}$	2 $\frac{13}{20}$	3 $\frac{97}{100}$
16	1 $\frac{23}{32}$	256	5 $\frac{4}{10}$	2 $\frac{7}{10}$	4 $\frac{5}{100}$
17	1 $\frac{25}{32}$	289	5 $\frac{5}{10}$	2 $\frac{3}{4}$	4 $\frac{82}{100}$
18	1 $\frac{27}{32}$	324	5 $\frac{6}{10}$	2 $\frac{16}{20}$	2 $\frac{12}{100}$

You may obſerve, that the Variety in the Size of the Saſh Quarrys, makes a great deal of Difference in the Superficial Area of the Painting-Work in each Particular, as well from the Square of the Glaſs, as the Bigneſs of the Frameing Timber.

The next Obſervation will be towards the Prices of the Lanterns, which you may obſerve, according to the eſtabliſhed Cuſtom, is equal, without having any manner of regard to the Variety of the Size, ſo that 10 *d.* for every Foot that any Lantern is on a Perpendicular Height, is as well given for a Lantern of 4 Foot Diameter, as one of 2 Foot Diameter, which will moſt certainly appear very Prepoſterous.

The Length or Heighth in Lanterns is very near as 2 to 1 to the Diameter of the ſame, and that a Ship of the largeſt Size, or 1700 Tun, has a Lantern of 9 Foot 3 Inches high, but the ſmalleſt ſized Ship, or one of 250 Tun, has a Lantern of 3 Foot high, which Difference is more than as 3 to 1; and being the Circumference of the large Ship's Lantern is 13 Foot, one with another, that one Foot high in ſuch a Lantern near the Middle will be 4 Foot of Painting; ſo that the Painter is allowed but 6 *d.* ¾ per Yard for twice painting the middle Part; but then he fetches it up in painting the Extreams, ſince Middle and Extreams are all of one Price, and perhaps 4 to 1 Difference in the Superficial Area. However, that's not all, ſince there is four third and fourth Rates for one firſt Rate, and there are alſo as many fifth and ſixth Rates, as there are third or fourth Rates, if you take the third or fourth Rates ſingle; beſides the ſmall Rates being more generally uſed, and of Conſequence the Lanterns oftener painted, from whence the Fault will appear more blameable, in making ſuch a wild Allowance for ſuch Work; and therefore I ſhall proceed to make a Calculation, according to the various Superficial Area's contain'd in each, which will make the Error more conſpicuous.

Diameter of the Lanterns in Feet and Inches. *Feet.*	*Inch.*	Length of the Lanterns in Feet and Inches. *Feet.*	*Inch.*	Circumference of the Lanterns in Feet and Inches. *Feet.*	The Number of Inches and Parts (in Height) of the Middle that will make one Yard on the Superficies, according to the Size of each Lantern. *Inch.*	Half the Diameter of each Lantern. *Feet.*	*Inch.*
4	2	8	2	13	8 [illegible]	2	1
3	6	6	7	11	8 [illegible]	1	9
3	8	6	6	11 [illegible]	8 [illegible]	1	10
3	0	8	2	12 [illegible]	8 [illegible]	2	0
3	0	5	6	9 [illegible]	11 [illegible]	1	6
2	10 1/2	6	0	9	11	1	5 1/4
2	5	4	8	7 1/2 7/10	13 1 6/10 5/10	1	2 1/4

Half the Circumference of each Lantern. *Feet.*	The Area of the Bottom and the Top put together in each Lantern. *Feet.*	The Price of Painting a Superficial Yard in each Lantern, with the Proviſo that they were equal to a Cylinder, according to the Proportion of their ſeveral and reſpective Diameters which I believe them very nearly to be conſidering their Bottom and Top and the Superficial Work in Tapering. *Pence.*
6 1/2	13 1/10 6/10	6 3/4
5 1/4	9 1/10 4/10	8 1/4
5 3/4	10 [illegible]	7 3/4
6 [illegible]	12 [illegible]	7 1/4
4 2/4 9/10	7 [illegible]	9 1/2
4 [illegible]	6 [illegible]	10
3 3/4 7/10	4 [illegible]	11 1/2

It appears in theſe Calculations that the Value of painting theſe Lanterns in each perpendicular Height is near as 2 to 1, that is, between the largeſt Lantern and the ſmalleſt Lantern; but the Area's of the Top and Bottom are near as 3 to 1, and of Courſe the Work in Tapering of the Bottom and Top, (provided the Figures are agreeable in the great and ſmall Lanterns) will be as 3 to 1 alſo, notwithſtanding I will not inforce theſe Calculations to be as exact as if they were meaſured by the niceſt Mathematical Rules; but I am poſitive they will be exact enough for common Practice, and that a very little Pains, from the Direction of ſuch a Rule, will leave no room for Sticklers.

Neither will I pretend to correct the Painter, and let him know that twice painting of Tin will be leſs Trouble than to paint four Times on Plank or Board; but ſtill I cannot but remind him of this, that great Part of the Lanterns are Glaſs, and not to be covered with Paint, and that the Cubical Area's of the Middle, will not in any manner anſwer the Superficial Area's of the Tapering upwards and downwards, although he may pretend to extreme Labour and loſs of Paint in working his Paint into the Coopings, and parted Work, and therefore the Price per Yard to paint the ſeveral ſized Lanterns muſt of Neceſſity ſtand as I have ſet it: and ſo I proceed to make a Calculation for the Oars.

The Oars will be very nearly adjuſted, by making 9 Inches and a half the Circumference throughout, from an Oar of 14 Foot long, to one of 19 Foot long, and then the Painting-Work will be as follows.

Feet. The Length of an Oar from 14 to 19 Ft. long.	*Feet.* The Superficial Area in Feet and Parts of Feet contain'd in each that is to be painted.	*Pence.* The Price per Yard for painting each according to the accustomary Allowance tho the Price should be 7*d.* p. Yard.	*Pence.* The Price for Painting each Oar should be according to their different Lengths.
14	11	7	9
15	12	6 ½	9 ¼
16	12 ¾	6	10 ½
17	13 ½	5 ¾	11
18	14 ¼	5 ¼	12
19	15	5	12 ¼

And ſo have I gone through the moſt Material Caſes, that will happen in painting moſt Ships, I ſhall, to finiſh this Obſervation, make ſome general Calculations, and ſet down what the Price ſhould be for the Ports, Rails, Head, Stern, and Galleries, according to what the Allowance is for painting a Yard of Work on a plain Superficies, believing there can be no better Guide to adjuſt this Branch of the Painter's Work.

The Prices of the Red Ports, agreeable to their different Area's one with another ſhould be

For the firſt Rate	8 ½
For the ſecond Size	8
For the third Size	7
For the fourth Size	6 ½
For the fifth Size	5 ¾
For the ſixth Size	5 ½

Theſe are the Prices that ſhould be given to the Painter to make them equal to 7 *d.* ½ per Yard for plain Colours.

The Prices of the imboſſed Rail, agreeable to the different Area's ought to be one with another, as aforeſaid.

For the firſt Size	2 $\frac{3}{10}$
For the ſecond Size	2 $\frac{1}{10}$
For the third Size	2
For the fourth Size	1 $\frac{8}{10}$
For the fifth Size	1 $\frac{44}{100}$
For the ſixth Size	1 $\frac{46}{100}$

Theſe are the Prices that ſhould be given to the Painter, for every Yard in Length, as it's term'd Running Meaſure to make the Price agreeable to 7 *d.* ½ per Yard for plain Colours.

I proceed now to ſhew the Prices for the Head, Stern and Galleries, and that I ſhall do from the Meaſure of the Ship, either from the Length of the Head, Depth of the Ship's Side in the Midſhips, or the Breadth of the Ship Extreme, believing that ſuch Dimenſions will be the moſt agreeable to obtain ſuch Proportions.

Feet.		*Fett.* Square of the Height.	*l.*	*s.* Price of the Head, Stern, and Gallery as cuſtom.
24	Height of the Side in the firſt ſized Ship	576	17	00
21	Ditto in the ſecond ſized Ship	441	14	00
14	Ditto in the third ſized Ship	196	9	00
13	Ditto in the fourth ſized Ship	169	5	00
11	Ditto in the fifth ſized Ship	121	3	05
9	Ditto In the ſixth ſized Ship	81	1	10

l.	*s.*	*d.* Price according to the Proportion of the Square Number, reducing it from the large Size.	*l.*	*s.*	*d.* Price in bringing the large Size to the Price of the ſmall, according to the Square Number.	*Feet.*	*In.* Length of each Ship's Head.
17	00	0	10	06	2	17	2
13	00	0	8	02	6	16	1
5	18	0	3	14	0	12	3
4	19	6	3	02	6	10	7
3	10	9	2	05	0	8	10
2	08	0	1	10	0	6	5

Feet.	In.		l.	s.	d.		l.	s.	d.	
295	4	The Square of the Length of the Head.	17	0	0	Price of the Head, Stern, and Galleries, agreeing the ſmall Ships to the great.	13	5	0	Price of the Head, Stern, and Galleries, agreeing the great Ships with the ſmall.
259	2		15	0	0		9	5	0	
151	2		8	15	0		5	8	0	
114	4		6	12	0		4	2	0	
65	6		3	16	0		2	6	4	
[illegible]	2		2	8	3		1	10	0	

Feet.		Feet.		Feet.		Feet.		l.	s.
48	Breadth of the ſix Ships, which multi-ply'd by the Depth is	24	× by	48	is	1152	Then to bring the Price of the ſmall Ships to the greateſt, according to this Proportion it will be	17	0
45		21		45		945		13	9
40		14		40		560		8	5
34		13		34		442		6	10
29		11		29		319		4	14
24		9		24		216		3	3

	l.	s.	d.
And to bring the Price of the large Ships to the ſmall, according to ſuch a Proportion it will be	7	17	0
	6	10	0
	3	16	9
	3	01	0
	2	04	0
	1	10	0

And theſe Proportions will be ſuitable, and the Value of one will undeniably be exactly in Proportion to the Value of the other, according to their various Superficies on the Head, Stern and Galleries, provided the Figures that are to be explain'd, correſpond, and are agreeable one to another, according to the different Bulk: However, ſuch Similitudes ſeldom happen, by reaſon of the Curioſity and Niceneſs which is required, in ſetting off and adorning a large Ship, to what it is in a ſmall Ship, excepting our Pleaſure Boats and Yatchs, which are purely built for Sight and Comelineſs, and therefore the exact Value of Painting Sterns, Galleries, and Heads, ſhould be adjuſted by meaſuring every Individual Figure that is placed on ſuch Parts; and yet I am really apt to believe, that firſt, ſecond, and third Rate Ship's Heads, *&c.* may be adjuſted according to their Superficial Area's, as aforeſaid; and alſo all fourth, fifth and ſixth Rates may be likewiſe put together, and adjuſted by their Superficial Area's, as of one ſet forth, ſince they are generally ſet out and adorn'd agreeable in every reſpect.

And having finiſhed the Hull of the Ship, I ſhall proceed to conſider of the Value of the Equipping, and firſt of the Maſts, which are moſt Material, as well in Price as being the firſt Movers in Rigging the Machine. The cuſtomary Prices are as follows.

OF

OF
MASTS.

New-England Maſts and Yards.

	Yards.	*Inches.*	*l.*	*s.*	*d.*
	Length in Yards.	Diameter in Inches.	The Value of each.		
Maſts.	36	36	148	01	0
	35	35	132	07	0
	34	34	118	00	0
	32	32	92	08	0
	31	31	80	17	0
	31	30	70	07	0
	30	29	60	18	0
	29	28	52	10	0
	Length in Yards.	Diameter in Inches.			
Bow-ſprits.	26½	35	88	17	2
	25	34	78	11	4
	24½	33	70	00	0
	24	32	61	11	2
	23½	31	53	17	4
	23½	30	46	17	2
	23	29	42	01	8
	23	28	34	19	4
	Length in Yds.	Diam. in Inch.			
Yards.	32½	22	41	08	0
	30½	21	33	06	0
	27	19	23	19	6
	26	18	21	10	6
	24	17	20	14	0
	24	06	15	00	0

Spars.	*Hands.*	*Feet.*	*Inch.*			
Small	1	12	1¼	0	0	2
Middling	2	18	2½	0	0	8
Boom	3	22	3¾	0	2	6
Barling	4	27	5	0	4	4
Cant	5	32	6⅜	0	7	6

Uphers or Balks from 30 Foot to 10 Foot long, and from 10 Inches to 3 Inches broad, at 15 *d. per* ſolid Foot, that is 3 *l.* 2 *s.* 6 *d. per* Load.

Riga and *Gottenburgh* Maſts.

Hands.	*Yards.*	*Inches.*	*l.*	*s.*	*d.*
The Number of Hands.	Length in Yards.	Diameter in Inches.	The Value of each.		
6	12	7¾	0	10	0
6½	12½	8¼	0	12	9
7	13	9	0	15	6
7½	13½	9½	0	19	0
8	14	10	1	2	6
8½	14½	10⅞	1	8	6
9	15	11½	1	14	6
9½	15½	12	1	17	3
10	16	12¾	2	0	0
10½	16½	13¼	2	10	0
11	17	14	3	0	0
11½	17½	14½	3	10	0
12	18	15¼	4	0	0
12½	18½	15⅞	4	10	0
13	19	16½	5	0	0
13½	19½	17⅛	6	0	0
14	20	17⅞	7	0	0
14½	20½	18½	7	11	6
15	21	19⅛	8	3	0
15½	21½	19¾	9	4	0
16	22	20¼	10	5	0
16½	22½	21	11	16	0
17	23	21¾	13	7	0
17½	23½	22¼	14	15	0
18	24	23	16	3	0
18½	24½	23½	21	11	6
19	25	24⅛	27	0	6
19½	25½	24¾	32	0	0
20	26	25½	37	0	0
21	27	26¾	47	5	0
22	28	28	54	5	0
23	29	29¼	64	0	0
24	30	30¼	74	0	0

Such Maſts as theſe are meaſured by Gitting, 4 Inches being allow'd for a Hand, and for every Hand the Maſt meaſures, 8 Inches in Length is allow'd from the But-end to the place of Girting.

And now I ſhall proceed to conſider and calculate ſome uſeful Tables to adjuſt their Meaſurement, and a true Rule for the Tunnage of each.

The Proportion approved on for the Diameter of the middle is $\frac{13}{14}$ of what they are at the Partners, middling or dividing the Maſt equally between the Head and the Heel. This is for Maſts and Fir Bowſprits.

Then for the Height of the Partners it is 2/3 of one Foot for every Inch the Maſt's Diameter is in the Partners; but for three Deck Ships it is 5/7 of one Foot, and for Bowſprits 2/3 of one Foot for the Bigneſs at the Gammoning *Place*.

The Square of the Bowſprits in Yards ('tis ſaid) is a Medium between the 1/4 and the 3/11 of the Girt in the Middle, which comes neareſt to the Method of the Navy, and makes the Square to be twice the Wane. This Saying I found enter'd in one of the Maſter Maſt-maker's Books.

A Bowſprit of 34 Inches at the Partners or Stem call'd the Bead, muſt be 1/2 at the Top and 4/5 at the But-end; 27 1/5, and 24 2/3 Yards long. And theſe Obſervations and proceeding Calculations are on *New-England* Trees, which are converted in *New England* into a Sixteen or Two and Thirty Square.

Diam	Height of the Partners from the Keel.		Diam in the middle.	Square in the middle.	Length in	Content in	Tuns.		Girt in the middle.		Square by a 1/4 Girt.	Square by a 1/3 Girt.
Inch.	*Ft.*	*In.*	*Inches.*	*Inches.*	*Yards*	*Feet.*	*Tuns.*	*Ft.*	*Ft.*	*In.*	*Inches.*	*Inches.*
New-England Masts.												
24	16	0	22 1/4	20	28	232	5	32	5	10	17 5/10	23
25	16	8	23 1/4	21	28 1/2	257	6	17	6	1	18 2/10	24 2/10
26	17	4	24 1/4	21 8/10	29	287	7	7	6	4	19	25 2/10
27	18	0	25 1/8	22 8/10	29 1/2	317	7	37	6	7 1/2	19 8/10	26 2/10
28	18	8	26 0	23 6/10	29 2/3	342	8	22	6	10	20 5/10	27 2/10
29	19	4	26 7/8	24 5/10	30	372	9	12	7	1	21 2/10	28 1/10
30	20	0	27 7/8	25 2/10	31	410	10	10	7	4	22	29 1/10
31	21	6	28 4/5	26 1/10	31 2/3	445	11	5	7	7	22 7/10	30 1/10
32	23	0	29 7/10	27 1/10	32	482	12	2	7	10	23 6/10	31 1/10
33	23	8 1/2	30 7/10	28	33	538	13	18	8	1	24 2/10	32 1/10
34	24	4 1/2	31 6/10	28 8/10	34	585	14	25	8	4	24 8/10	33 1/10
35	25	0	32 5/10	29 5/10	35	630	15	30	8	6	25 5/10	34
36	25	8 1/2	33 4/10	30 2/10	36	672	16	32	8	9	26 2/20	35
37	26	6	34 4/10	31 1/10	37	738	18	8	9	0	27	35 8/10
38	27	2 1/2	35 3/10	32	38	804	20	4	9	3	27 5/10	37
39	27	11	36 3/10	33	38 1/2	868	21	28	9	6	28 5/10	38
New-England Bowſprits.												
23	15	4	21 3/10	18 8/10	14	132	3	12	5	7	16 8/10	21 2/10
24	16	0	22 2/10	20	16 1/4	152	3	32	5	10	17 5/10	23
25	16	8	23 2/10	21	18 2/3	170	4	10	6	1	18 2/3	24 2/10
26	17	4	24 1/10	21 7/10	19	188	4	28	6	4	19	25 2/10
27	18	0	25	22 6/10	20	212	5	12	6	6 1/2	19 4/10	26
28	18	8	26	23 6/10	21	242	6	2	6	10	20 5/10	27 7/10
29	19	4	26 9/20	24 5/10	22	272	6	32	7	1	21 2/10	28 1/10
30	20	0	27 8/10	25 2/10	23	300	7	20	7	4	22	29 1/10
31	20	8	28 8/10	26 1/10	23 1/2	330	8	10	7	7	22 7/10	30 1/10
32	21	4	29 7/10	27 1/10	24	364	9	4	7	9	23 5/10	31
33	22	0	30 7/10	28	24 1/3	395	9	35	8	1	24 2/10	32 1/10
34	22	8	31 6/10	28 8/10	24 2/3	420	10	20	8	3 1/2	24 8/10	33 1/10
35	23	4	32 5/10	29 5/10	25	450	11	10	8	6 1/2	25 5/10	34
New-England Yards												
17	——		14 9/10	12 2/10	26 2/3	76	1	36	3	6 1/2	10 5/10	14 1/10
18	——		15 8/10	14 4/10	27	116	2	36	4	2	12 4/10	16 5/10
19	——		16 6/10	15	28 1/2	131	3	11	4	4	12 9/10	17 2/10
20	——		17 5/10	15 8/10	30	148	3	28	4	7	13 8/10	18 4/10
21	——		18 4/10	16 1/10	31 1/2	180	4	20	4	10	14 5/10	19 2/10
22	——		19 2/10	17 2/3	33	202	5	2	5	0 1/2	15	20
23	——		2 1/10	18 8/10	34 1/2	256	6	16	5	3	15 7/10	20 9/10
24	——		21	20	35 1/2	296	7	16	6	2/10	16 5/10	21 9/10

I proceed now to the Rough Maſts that are brought from *Riga* and *tenburgh* without Squaring.

Hands	Yards long.	Feet from the Butt.		Diam. at the Mea ſurePlace.	Girt in the middle for Timber Meaſure.		Square in the mid-dle for Timber Meaſure	Content in Feet.
		Feet.	*In.*	*Inches.*	*Feet.*	*In.*	*Inches.*	
24	30	16	0	30	7	4	25	391
23	29	15	3	29	7	1	24	349
22	28	14	7	28	6	10	20½	332
21	27	14	0	26½	6	5	19¼	208
20	26	13	4	25	6	0	18	170
19	25	12	6½	24	5	8	17	149
18	24	12	0	23	5	7	16¾	144
17	23	11	4	21½	5	1	15¼	110
16	22	10	7	20⅓	4	10	14½	95
15	21	10	0	19	4	9	14¼	88
14	20	9	4	17½	4	6	13½	74
13	19	8	7½	16½	4	4	13	67
12	18	8	0	15	4	0	12	54
11	17	7	4	14⅔	3	10	11½	47
10	16	6	8	12½	3	4	10	33
9	15	6	0	11½	2	10	8½	23
8	14	5	4	10	2	4	7	14
7	13	4	8	8½	2	0	6	9⅝
6	12	4	0	7½	1	10	5½	9⅜

You may obſerve in this Calculation, that the Number of Yards for Length is juſt 6 more than the Number of Hands marked on the Tree, and the Top-end ought to be ⅔ of the Butt-end: But as to the Truth of ſuch Rules, I ſhall refer you to obſerve in other Places of my firſt Part in this Volume.

I proceed now to adjuſt the Prices of the Maſts, *&c.*

Diameter.	Circumference.	Half Diameter.	Half Circumferenc.	Area of the Diameter of the Circle at the Partners.	Cube of the Area.	Area of the Maſt in Feet, counted by a Cylinder.
36	113	18	56½	1017	7 9/144	853
35	110	17½	55	962	6 68/100	701
34	1 6½	17	53¼	905	6 3/10	642
32	100	16	50	800	5 53/100	532
31	97	15½	48½	750	5 23/100	486
30	94	15	47	710	4 8/10	460
29	90½	14½	45¼	644	4 47/100	402
28	88	14	44	616	4 27/100	371

Cube of the Content in Feet as a perfect Cylinder.	The Price per Foot of each Maſt, according to a Cubical Proportion of the Content as a Cylinder.			The Price of the Maſt from the Cube of the Content.			The Cube of the Area of the Maſt in the Partners.
	s.	*d.*	*q.*	*l.*	*s.*	*d.*	
9 5/10	3	7	3	155	9	7	10 33/100
8 9/10	3	4	3	119	0	10	9 8/10
8 6/10	3	3	2	105	13	3	9 6/10
8 1/10	3	1	1	82	11	5	9 4/10
7 8/10	3	0	3	74	9	4	9 3/10
7 7/10	2	11	2	68	1	0	9
7 4/10	2	10	1	57	19	2	8 9/10
7 3/10	2	9	0	51	0	3	8 7/10

The

The Price per Foot according to the Cubical Proportion of the Area of the Diameter.			The Total Sum for each Maſt from the Cubical Proportion from the Area of the Diameter.			Length of each Maſt.	Diameter of the Partners in Inches.
s.	d.	q.	l.	s.	d.		
3	7	3	155	9	7	108	36
3	6	1	123	8	1	105	35
3	5	2	111	0	3	102	34
3	4	3	99	6	7	96	32
3	3	3	80	9	10 ¼	93	31
3	3	0	74	15	6	93	30
3	1	3	63	4	7 ½	90	29
3	1	0	57	3	11	87	28

Theſe Sizes are the common Meeting for tranſporting of Maſts from *New-England*, though they do not nicely correſpond to thoſe Sizes, which are approved requiſite for Ships Maſts, as you may more particularly ſee in the firſt Part, where I have ſet down the exact Sizes of Maſts and Yards, from the biggeſt Ship's Dimenſions to one of 20 Foot broad, which I preſume is as ſmall a Ship as is of three Maſts.

I cannot ſay, whether thoſe that convert the Maſts beyond Sea have any private Caution to ſhape their Trees, or whether they do endeavour to continue their Bigneſs as much as poſſible; however, if they have not ſome particular Cautions, they may chance to gild their Length contrary to the Suitableneſs of the Diameter, ſince, as you may obſerve in my preceeding Tables, that a Ship which requires a Maſt of 30 Inches ½ Diameter, doth alſo require the ſaid Maſt to be 100 Foot ½ long; and a Maſt of 26 Inches ⅔ Diameter, ought to bee 88 Foot long. Indeed as to the ſhaping of them, and reducing ſuch large Maſts into ſuch a Poſition, that they may have little more Wood left than what is requiſite for Coaking and Tabling for the Oak Cheeks to fay and faſten them, it muſt by all conſiderate Perſons be allowed highly neceſſary, both as to the Advantage of Tranſporting, and alſo for diſcovering the Defects which may lye concealed before they be ſo reduced, and therefore it cannot be thought any ways unreaſonable to allow the Merchant to have the Bigneſs of the Maſt in the Place of the Partners or biggeſt Place of the Maſt for the Meaſuring Place, and that according to ſuch a Meaſure of Bigneſs, and the extream Length, the Area ſhould be found, and the Content in either Feet or Inches ſhall be allowed the Merchant for any Maſt, according to a Cylinder, made by multiplying the Area of the Circle at the Partner, or biggeſt Place of the Maſt (if it be ſhaped like a Ship's Maſt) into the Length extream, and that the Sum ſo found ſhall be deem'd the true Content of ſuch a converted Tree.

For in rough Trees that are brought from *Gottenburgh*, and ſeveral other Parts in the Eaſt Country, the Maſts are principally adjuſted from the Bigneſs the Maſts hold near the Partner, which for a more general Calculation is allowed to be for every Yard the Maſt is in Length from one End to another, 8 Inches to be ſet off from the biggeſt End upward, and where that ſaid Number of 8 Inches for every Yard the Maſt is long interſects, ſhall be allowed the Place of Meaſure, either as Inches or Number of Hands, which Hand is 4 Inches meaſured by Girting, or properly the Circumference of the Tree at that Place; and indeed I cannot ſee any Reaſon why the Price of Maſts may not as well be adjuſted this way, as to meaſure them in the common Place of Meaſure, or middle of the Tree, and there to take the ⅓ or ¼ of the Girt for the Square of the Tree, which is very Erroneous. Indeed the true way to meaſure ſuch Trees is to reduce them to a Conical Figure, as the Mathematicians deſcribe; but that way is ſo very tedious, that I cannot recommend it to be every Time made uſe of, that a parcel of Maſts are to be meaſured, and therefore if a nice and exact way be required to adjuſt the Content of the Tunnage, or the Loads there are contain'd in ſuch Materials, there might be Tables readily calculated of rough Trees, according to either Pyramidical or Conical Shapes, I ſhall juſt ſet down the Price per Load of theſe preceeding Trees, and then paſs on to the adjuſting the Price of the Bowſprits.

Content in Feet.	Content in Loads.		Price of the whole.			Price per Feet.			Value per Load.			Content in Tuns.		Price per Tun of converted Maſts.		
	Load.	*Ft.*	*l.*	*s.*	*d.*	*s.*	*d.*	*q.*	*l.*	*s.*	*d.*	*Tun.*	*Ft.*	*l.*	*s.*	*d.*
852	17	3	155	9	7	3	7	3	9	2	3 ¼	21	13	7	5	10
701	14	1	123	8	1	3	6	1	8	16	0 ½	17	21	7	0	10
642	12	42	111	0	3	3	5	2	8	12	11	16	2	6	18	4
532	10	32	90	6	7	3	4	3	8	9	9 ½	14	12	6	15	10
486	9	36	80	9	10 ½	3	3	3	8	5	7 ½	12	6	6	12	6
460	9	10	74	15	6	3	3	0	8	2	6	11	20	6	10	0
402	8	2	63	4	7 ½	3	1	3	7	17	3 ½	10	2	6	5	10
371	7	21	57	3	11	3	1	0	7	13	2	9	11	6	3	4

I ſhall paſs on to calculate the *Prices* of the Bowſprits, which are alſo converted as near their ſeveral Shapes as can be thought reaſonable.

Inches.	Circumference.	Half Diameter.	Half Circumferenc.	Area.	Area of the Head in Feet and Parts.	Length in Feet.	Content in Feet as a Cylinder.	Cube of the Content as a Cylinder.	Price per Foot.		
						Feet.			*s.*	*d.*	*q.*
35	110	17 ½	55	962	6 $\frac{68}{100}$	79 ½	531	8 $\frac{1}{10}$	3	1	1
34	106 ½	17	53 ¼	905	6 [illegible]	75	472	7 $\frac{8}{10}$	2	11	2
33	103	16 ½	51 ¾	849	5 $\frac{9}{10}$	73 ½	434	7 $\frac{6}{10}$	2	10	2
32	100	16	50	800	5 $\frac{55}{100}$	72	398	7 $\frac{7}{20}$	2	9	2
31	97	15 ½	48 ½	750	5 $\frac{21}{100}$	70 ½	367	7 $\frac{3}{20}$	2	8	3
30	94	15	47	710	4 $\frac{9}{10}$	70 ½	337	7	2	8	0
29	90 ½	14 ½	45 ¼	644	4 $\frac{47}{100}$	69	307	6 $\frac{8}{10}$	2	7	0
28	88	14	44	616	4 $\frac{27}{100}$	69	295	6 $\frac{13}{20}$	2	6	1

I obſerve, that the Area of the Baſe, or Diameter of the Maſts at the Partners cubed, affords a Proportion nearer to the Cuſtomary Price than a Cubical Proportion obtain'd from the whole Content in Feet, but why the extra Length, or a Variety in Lengths, ſhould not be minded, I profeſs is a Parodox to me.

The Price of the whole Tree from a Cubical Proportion of the whole Content.				Area of the Bead in Inches.	Cube of the Content of the Bead.	Price per Foot from the Area of the Bead.		
l.	*s.*	*d.*	*q.*			*s.*	*d.*	*q.*
82	8	3	3	962	9 $\frac{9}{10}$	3	6	2
69	16	2		905	9 $\frac{7}{10}$	3	5	3
62	7	9		849	9 $\frac{5}{10}$	3	5	0
55	8	8		800	9 $\frac{3}{10}$	3	4	1
50	0	10	1	750	9 $\frac{1}{10}$	3	3	1
44	10	0		710	8 $\frac{9}{10}$	3	2	1
39	13	1		644	8 $\frac{6}{10}$	3	1	2
37	3	7	3	616	8 $\frac{5}{10}$	3	0	2

The Price according to a Cubical Proportion of the Area of the Baſe or Bead.			Content in Loads and Feet.		Content in Tuns and Feet,		Price per Load from the Cube of the whole Content.		
l.	*s.*	*d.*	*Load.*	*Ft.*	*Tun.*	*Ft.*	*l.*	*s.*	*d.*
94	0	7 ½	10	31	13	11	7	15	2 ½
82	6	2	9	22	11	32	7	7	11
73	12	10 ½	8	10	10	34	7	3	11
66	14	11 ¾	7	48	9	38	6	10	7
59	19	10 ¼	7	17	8	7	6	16	5 ½
53	15	0 ¾	6	37	8	17	6	13	4
47	19	4 ½	6	7	7	27	6	9	2
44	17	3 ½	5	45	7	15	6	6	0 ½

The Price per Tun according to the whole Content.			Price per Load from the Area of the Bead.			Price per Tun from the Area of the Bead.		
l.	*s.*	*d.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
6	4	2	8	16	0 ½	7	1	8
5	18	4	8	13	11 ½	6	19	2
5	15	0	8	10	10	6	16	8
5	11	0	8	7	8	6	14	2
5	9	2	8	3	6 ½	6	10	10
5	6	8	7	19	4 ½	6	7	6
5	3	4	7	16	4	6	5	
5	0	10	7	12	1	6	1	8

You may obſerve in theſe Calculations, that a Cubical Proportion from the whole Content of each Bowſprit (allow'd as a perfect Cylinder) agrees beſt with the Prices of the ſmalleſt Bowſprits, according to a cuſtomary Allowance, and a Cubical Proportion from the Area of the Maſt's Diameter at the

Bead or biggeſt Place of each Bowſprit, agrees beſt to the biggeſt Bowſprits, according to Cuſtom; ſo that neither of the ſaid Rules is found General: And therefore I am of Opinion, if all Bowſprits are made in Proportion one to another, according to their reſpective Lengths and Bigneſs, then our cuſtomary Prices are Erroneous, and ought not to be made uſe of; but perhaps there may be an Objection made, that large and ſmall Bowſprits ought not to be made Similar in every reſpect, and therefore the Prices ought not to be agreeable throughout: But this I believe may be eaſily anſwer'd, ſince every Maſt has his Dimenſions from the Bulk of the Ship; and if the Main-Maſt is made Similar to the Ship, the Fore-Maſt will be to the Main-Maſt, the Bowſprit to them, and indeed every particular Member ought to correſpond one to another, according to the Length and Bigneſs of the Main-Maſt, and therefore ſmall Bowſprits may be Tapered in exact and due Proportion, according to the Bigneſs they are made at the biggeſt Part, as well as large Bowſprits: Indeed, if there is any Difference, the ſmall Bowſprits may be moſt reduced and leſſen'd upwards, ſince the biggeſt has a Top, and Truſſel and Croſs-trees different from the ſmall Bowſprits; but however that Difference will be found but ſmall.

I ſhall in the next Place conſider the Nature and Uſe of converting large Yards, and making ſuch Tapered Parts (that are reduced quite contrary to the Natural Growth) according to ſuch Faſhions, that unleſs there are Trees which very nicely ſuit ſuch required Lengths and Breadths, it muſt be allowed a very extravagant and unreaſonable Waſte.

Firſt, I ſhall draw one Parallel between the Make of ſuch large Yards, either in one Piece or in two Pieces, for which purpoſe I ſhall make uſe of a Yard that is 97 Foot and $\frac{1}{2}$ long, and 22 Inches Diameter in the Slings, which is the middle of the Yard; and ſince the middle of the Trees are near as 11 to 12 to what they are at the Meaſuring Place, this Tree muſt be 24 Inches Diameter, and 97 Foot and $\frac{1}{2}$ long, to make ſuch a Yard in one Piece. The Diameter $\underset{12}{24}$ Inches, Circumference $\underset{37\frac{1}{2}}{75}$, Area 450 Feet, or 3 Foot Inches; the Content is 303 Feet and $\frac{1}{4}$, Cube of the Content is 6 $\frac{15}{20}$, Price *per* Foot is 2 *s.* 6 *d.* $\frac{3}{4}$, for 303 Feet $\frac{1}{4}$ is 38 *l.* 17 *s.* 0 *d.* $\frac{3}{4}$, the Price of the Tree to make ſuch a Yard in one Piece.

Then for two Pieces ſuitable to make ſuch a Yard, they muſt be each 65 Foot long, and 22 Inches Diameter; then the Circumference is 69, the Area is 379 Foot and a half, or 2 Foot and 63 Inches; Content is 159 Foot $\frac{1}{13}$ of a Foot, the Cube of which Content is 5 $\frac{9}{20}$; Price *per* Foot is 2 *s.* 0 *d* $\frac{3}{4}$, for 159 Foot $\frac{1}{13}$ is 16 *l* 8 *s.* 0 *d.* $\frac{3}{4}$; then the two Trees is 32 *l.* 16 *s.* 1 *d.* $\frac{1}{2}$, ſo that there remains out of 38 *l.* 17 *s.* 0 *d.* $\frac{3}{4}$, 4 *l.* 0 *s.* 11 *d.* $\frac{1}{4}$, which Sum of 6 *l*: 0 *s.* 11 *d.* $\frac{1}{4}$, will over provide Workmanſhip and Materials to Scarph or Splice the two Pieces together, and therefore it will be cheaper to put two Pieces to make large Yards, than to make them in one ſingle; ſo that unleſs ſuch long ſlender Trees are upon decaying, and cannot be preſerved to make ſtanding Maſts, it would be much better to let them continue, and be preſerved for more material Uſes, than to cut them for what may be plainly ſeen can be provided much cheaper, and more ſubſtantial and properer for the Uſe.

I ſhall not therefore proceed any further in adjuſting the Prices of the Yards, by reaſon I am of Opinion, the Method of making large Yards out of one Tree is an unreaſonable Waſte; but if it muſt be ſo continued, then I ſhall give one neceſſary Caution, that the Bigneſs ought to be allowed at the great End, or in Proportion to the middle, as 12 to 11; ſo that if the large Yards are brought over ready converted in one Piece, then the Diameter of ſuch Yards ought to be $\frac{1}{11}$ more than what they hold in the Slings or largeſt Place, and that Allowance multiply'd into the Length ſhall be deem'd the Content of the Tree, and the Price allowed in Proportion, as the ſaid Content is to the Content of either Maſt or Bowſprit: And ſo I paſs on to conſider of the

Prices allowed for the Maſts, or indeed I may ſay Fir Trees, by reaſon they are brought over Rough as they firſt grew, only the Boughs and Top being cut off.

Then Rough Maſts are meaſured at the Meaſuring Place, which is for every Yard the Maſt is long you allow 8 Inches to be ſet off from the Butt upwards, as was aforeſaid, at which Place you Girt the Maſt with ſome Springing Inſtrument that will go round him, and for every 4 Inches that he Girts at that Place, he is called a Maſt of ſuch a Number of Hands, and then to the Number of Hands you add 6, which chalks you out the Length; but the Unreaſonableneſs of ſuch a General Method to find the Length, I have mentioned in Page , and therefore ſhall ſay nothing of it here, but paſs on to the Calculation.

Number of Hands.	Circumference.	Diameter.	*Inches.* Area.	Cube of the Area in the Partners.	Length in Yards.	Length in Feet.	Length in Inches.
6	24	7 13/20	46	3 4/10	12	36	432
6 ½	26	8 3/10	54	3 8/10	12 ½	37 ½	450
7	28	8 9/10	62	3 19/20	13	39	468
7 ½	30	9 6/10	72	4 3/10	13 ½	40 ½	487
8	32	10 2/10	82	4 2/10	14	42	504
8 ½	34	10 8/10	91	4 5/10	14 ½	43 ½	524
9	36	11 1/10	101	4 13/20	15	45	540

Ft.	*Inch.* Content in Feet and Inches.	Cube of the Content	*d.* Price per Foot from the Cube of the Content.	Number of Hands.	Length in Yards.	*l.*	*s.*	*d.*	*q.* Value from the Cube of the Content	Price *per* Foot from the Area of the Partners.
11	864	2 1/4	10 ½	6	12	0	10	0	3	10 ½
14	108	2 4/10	11 ¼	6 ½	12 ½	0	13	2	0	11 ¼
16	1368	2 11/20	12	7	13	0	16	9	0	11 ½
20	1504	2 3/4	12 ¾	7 ½	13 ½	1	1	0	3	12 ¼
23	1584	2 17/20	13 ½	8	14	1	6	10	3	12 ¾
27	1628	3 1/20	14 ¼	8 ½	14 ½	1	12	9	1	13 ¼
31	1712	3 2/10	15	9	15	1	19	6	0	13 ¾

l.	*s.*	*d.*	*q.* The Value from the Cube of the Area at the Partners.
0	10	0	3
0	13	2	0
0	16	0	3
1	00	8	2
1	5	5	0
1	10	5	3
1	16	2	2

Having ſhewn a Method how to adjuſt the Prices of ſuch Rough Trees, and bring the intrinſick Value (which always will be various, according to Times and Seaſons of obtaining ſuch Goods) to general Heads, I ſhall not in this Place go through with the whole Calculation, and adjuſt the Value of every ſized Tree, as is ſet down according to the cuſtomary Allowances; but ſhall paſs to the latter part of the Table, and there take a few of the largeſt Sized Trees, which will fall in amongſt the Dimenſions of the converted Maſts and Bowſprits, in which I ſhall endeavour to ſhew how near one comes to anſwer the Price of the other.

Numb. of Hands.	Circumference.	Diameter.	Area at the Partners in Inches.	Cube of the Area	Length in Yards	Length in Feet.
18 ½	74	23 ½	434 ¾	7 5/10	24 ½	73 ½
19 ½	78	24 ¾	483	7 ½ 7/10	25 ½	76 ½
20	80	25 ½	510	8	26	78
21	84	26 ¾	562	8 3/10	27	81
22	88	28	615	8 5/10	28	84
23	92	29 ½	675	8 8/10	29	87
24	96	30 ½	735	9 1/10	30	90

Feet.	*Inch.* Content in Feet and Inches.	Cube of the Content.	*s.*	*d.*	*q.* Value per Foot from the Area of the Partner Cubed.	*l.*	*s.*	*d.* The Value from the Cube of the Area at the Partner.
220	21/144	6 1/20	2	0	2	22	05	1 ½
255	1 306/1728	6 4/10	2	1	1	26	17	0
276	1 36/144	6 ½ 1/10	2	1	3	29	12	9 ½
316	1 33/144	6 ½ 7/10	2	2	2	34	18	6 ¼
358	108/144	7 3/20	2	3	1	40	14	8 ½
407	117/144	7 2/20	2	4	1	47	10	3 ¾
459	1 54/144	7 7/10	2	5	1	56	00	0 ¼

s.	d.	q.	
2	4	2	Value per Foot from the Cube of the Content.
2	6	0	
2	6	3	
2	8	0	
2	10	0	
2	11	0	
3	00	0	

l.	s.	d.		
25	4	6		Value from the Cube of the Content of the whole Tree.
31	17	11		
35	7	10	½	
42	4	0		
50	19	5		
59	9	7		
68	18	1	½	

l.	s.	d.		
5	18	9		The Price per Load from the Cube of the whole Content.
6	5	0		
6	8	1	½	
6	13	4		
7	1	8		
7	5	10		
7	10	0		

l.	s.	d.	
4	15	0	The Price per Tun from the Cube of the Content.
5	0	0	
5	2	6	
5	6	8	
5	13	4	
5	16	8	
6	0	0	

l.	s.	d.		
5	2	1		Price per Load from the Cube of the Area in the Partner.
5	5	2	½	
5	7	3	½	
5	10	5		
5	13	6	½	
5	17	8	½	
6	1	10	½	

l.	s.	d.	
4	0	10	The Price per Tun from the Cube of the Area in the Partners.
4	4	2	
4	5	6	
4	8	4	
4	10	10	
4	14	2	
4	17	6	

I am not ſo much ſurprized to ſee that my Calculation will not exactly meet Cuſtom, but that in the converted Maſts which are brought from *New England*, a Cubical Proportion of the Area at the place aſſigned for the Partner, comes neareſt to the cuſtomary Prices; and in thoſe Rough Maſts which are brought from *Norway*, and the like, a Cubical Proportion of the whole Content ſuits beſt to the cuſtomary Prices.

Neither can a Man think it very ſtrange, that the Price either *per* Foot or *per* Load of theſe Rough *Norway* Maſts (which are brought Rough with the Sap and Defects, moſt ſecretly hid by ſuch a Rough Importation) ſhould be full as much as the converted Trees that are brought from *New England*, ſince the latter are brought from our own Manufactures, and the other from a ſtrange Country.

But the matter that ſurprizes me moſt is, to obſerve the Price of ſuch large Timber that is brought ſo far as *New England* is from us, as you may ſee that a Tree containing upwards of 8 Loads, is obtain'd for leſs than 8 *l. per* Load, which indeed is far cheaper than ſuch large Timber is obtained that ſtands in Old *England*, as you may ſee in my *Ship-Builder's Aſſiſtant*, that large Beams of 18 Inches Square and 42 Feet long, containing but 95 Feet, or 145 Loads, the Purchaſe is thought to be reaſonable at 9 *l.* 5 *s. per* Load; nay, converted Plank, or any other part of a Ship, is full as dear in Proportion to the Magnitude of the ſame.

And if what I have been credibly inform'd of (from one of the Principal Officers and Commiſſioners of the Navy) is true, that ſome Timber which has been brought out of the *Severn*, from ſome Parts of *Somerſetſhire* or *Herefordſhire*, or ſome other adjacent thereto, has ſtood the Government in 12 *l. per* Load, it would be much to our Advantage to look into *New England* and *Virginia* for Oak Timber, which will be found very plenty there, and never to Diſtruſt of wanting or being neceſſitated for Timber, as long as ſuch Prices can be afforded as 12 *l.* a Load for only common Ship Timber.

The Building of Ships at *New England* indeed would be much cheaper than to fetch Timber from thence and build them here, provided good Methods were taken for ſupplying ſome Defects, and the neceſſary Wants of that Foreign Kingdom in the Performance; but if inſtead of ſending able and experienc'd Ship-builders to perform ſuch Services, a Relation or Servant is ſent to Super-intend, and go exactly by ſuch a Maſter's Direction, without knowing or being able to give any Reaſon to the contrary. This indeed has been, and what has begot an ill Omen on *New England*, that the Publick Ships cannot be built there.

It cannot be denied, that a good Man may build a Ship as well in one Place as another, provided the Materials and Workmen be alike; and thus much I will ſay, that I have ſeen Ships as well put together, and alſo ſhap'd, that have been built in *New England* as ever I ſaw in Old *England*, and excepting the Garniſhing, and Beautifying Part, which chiefly lyes at the Directors Door, they have been really and ſincerely very good Ships.

I had almoſt forgot one thing, and that is to our large Keel Pieces, that they are brought far dearer to the Uſe than *New England* Maſts, and ſo you would really find in ſeveral other Wooden Materials that relates to Ship-building, which muſt either be owing to our Kingdom's being Weeded of ſuch large and uſeful Timber, or otherwiſe to our ſuffering the Price to be enhanced, without endeavouring to provide a Remedy.

I ſhall proceed in conſidering the Price of Fir Timber throughout, with ſome uſeful Cautions for ſizing of it, according to the common Uſe requiſite in Shipping, that ſo it may be converted as near as poſſible to the Uſe, and firſt of ſuch ſmaller ſized Maſts that are termed Spars.

		Hands.	*Ft.*	*Inch.* Diameter.	*s.*	*d.* Price each.	Circumfer.
Spars	Cant	5	32	6 $\frac{1}{8}$	7	6	20
	Barling	4	27	5	4	4	16
	Boom	3	22	3 $\frac{3}{4}$	2	6	12
	Middling	2	18	2 $\frac{1}{2}$	0	8	8
	Small	1	12	1 $\frac{1}{4}$	0	2	4

Diameter.	Area of the Place at the Partners.	Content in Feet and Parts.	Content in Inches.
6 $\frac{4}{10}$	32	7 $\frac{192}{1728}$	12288
5 $\frac{1}{10}$	20	3 $\frac{1296}{1728}$	6480
3 $\frac{17}{20}$	11 $\frac{1}{2}$	1 $\frac{1308}{1728}$	3036
2 $\frac{11}{20}$	5 $\frac{1}{10}$	0 $\frac{1101}{1728}$	1101
1 $\frac{23}{50}$	1 $\frac{48}{100}$	0 $\frac{213}{1728}$	213

1 $\frac{94}{100}$ Cube Root 9 *d.* per Foot, or 5 *s.* 4 *d.* for the Cant-ſpar of this Size; but the Cuſtomary Price is near $\frac{1}{3}$ more, or near 13 *d.* per Foot more than is allowed for 8 Hand Maſts.

1 $\frac{56}{100}$ Cube Root of Barling-ſpars Content, it's 7 *d.* $\frac{1}{4}$ per Foot, or 2 *s.* 2 *d.* $\frac{3}{4}$, but the Cuſtomary Price is near double as much, or near 14 *d.* per Foot, and more than is given for the Cant-ſpars.

1 $\frac{21}{100}$ Cube Root of the Boom-ſpars, it's 5 *d.* $\frac{3}{4}$ per Foot, or 10 *d.* $\frac{1}{4}$ each; but the Cuſtomary Price is near treble as much, or 17 *d.* per Foot.

10 $\frac{1}{4}$ Inch Cube Root of the Middling-ſpar's Content, it's 4 *d.* $\frac{1}{4}$ per Foot, or 2 *d.* $\frac{1}{2}$ each; but the Cuſtomary Price is near treble as much, or 13 *d.* $\frac{1}{2}$ per Foot.

6 Inches Cube Root of the Small-ſpars, it's 2 *d.* $\frac{1}{2}$ per Foot, or 1 *d.* $\frac{1}{4}$ each, the Cuſtom is near 8 times as much, or 16 *d.* per Foot.

	Inch.		*s.*	*d.*	
Spruce Deals	4	From 3 *l.* to 5 *l.* per Load, or	43	4	each.
	3		18		
	2 $\frac{1}{2}$		12		
	2		10		

If a Load of Timber be converted into ſuch Deals, then there will be of each Sort as follows.

Feet.				*Feet.*		*Foot.*	*Inch.*	
150	or	3	Deals of	50	Long and	1		Broad.
200		4		50		1		
250		5		50		0	11 $\frac{1}{2}$	
300		6		50		1		

Cube Root of 50 is 3 $\frac{7}{10}$, but the Content in a round Tree will be at leaſt 78 Foot $\frac{18}{144}$, Cube Root of which is 4 $\frac{4}{10}$.

I ſhall allow the 4 Inch Deals to be cut out of Timber, which will coſt 20 *d.* per Foot, according to the Value of the Maſt from the Cube of the Content, ſo that the Deals after they are ſawn, ſhall contain 50 Foot, and the moſt ſuitable will be them of 15 Inches Broad, and 32 Foot long, the rough Timber to make ſuch three Deals muſt contain 78 $\frac{18}{144}$ Feet, and the ſawing will be at leaſt 300 of Work, which I ſhall value at 12 *d.* per Hundred; for in ſuch Saw-Mill Countries the Charge will be but ſmall.

Uphirs and Baulks from 30 to 10 Foot long, and from 10 Inches to 3 Inches broad, at 15 *d.* per Foot, that is 3 *l.* 2 *s.* 6 *d* per Load.

Feet.			*Inch.*
40	0	Superficial Foot in each of the Deals	4
26	6		3
19	6		2 ½
13	0		2

The Charge of the Timber to cut the four Inch Deals will be 6 *l.* 13 *s.* 2 *d.* ½, but in Conſideration that there will be 4 Slabs cut off as Waſte, I ſhall cut off the Charge of ſawing, which ſhall go in lieu of the Slabs left to the Proprietor, and then the ſame will be 6 *l.* 10 *s.* or 2 *l.* 3 *s.* 4 *d.* each Deal, which will be 10 *d.* ¼ per Foot, for a 4 Inch Deal.

I ſhall next ſet down the Dimenſions of the other Deals ſuitable in Strength to the 4 Inch Deals.

Inc. thick	Inc. broad	Area of Breadth and Thickneſs.	Length ſuitable to make the Strength equal. *Feet.*	Rough Timber requiſite for ſuch Deals.
4	15	60	32	81 $\frac{18}{144}$
3	14	42	23	80 $\frac{5}{10}$
2 ½	13	32 ½	17 ½	79
2	12	24	13	77

Content of the Pieces to be cut.	Cube of the Content.	Price per Foot. *s.*	*d.*	Value of the whole Timber. *l.*	*s.*	*d.*
78 $\frac{18}{144}$	4 $\frac{3}{10}$	1	8	6	10	2 ½
50	3 $\frac{7}{10}$	1	5 ¾	5	19	9 ¾
32	3 $\frac{2}{10}$	1	3	4	18	9
20	2 $\frac{7}{10}$	1	0 ½	4	00	2

Sawing-Work. *Feet.*	Charge of Sawing. *s.*	*d.*	Charge of Timber and Sawing. *l.*	*s.*	*d.*	Content in Feet of the ſeveral Deals producted by the Timber.
300	3	0	6	13	2 ½	150
350	3	6	6	3	3 ¾	200
400	4	0	5	2	9	246
450	4	6	4	4	8 ½	300

Price per Foot of the Deals converted *d.*	Number of Deals.	Price of each. *l.*	*s.*	*d.*	*q.*	Price of each Deal when the Sawing is deducted. *l.*	*s.*	*d.*	*q.*
10 ¼	3 ¾	1	14	2	0	1	13	2	0
7 ¼	7 ⅓	0	16	0	1	0	15	6	3
5 ½	12 ⅓	0	8	11	1	0	8	8	0
4 ¾	23	0	4	7	1	0	4	5	0

And from theſe Calculations I ſhall give you one Rule that may be materially uſeful for adjuſting the Prices of converted Deals, and Fir Timber, obſerving how very Promiſcuous it is imported, eſpecially in what is call'd ordinary Deals, where the Price is generally at 12 *d.* each, although ſome Deals ſhall be 8 Foot, others 9 Foot long, ſome 10, 11, nay 12, and perhaps others 7; the Breadth alſo as various, ſome 12 Inches, others 11, to 8 and 7 Inches broad; the Thickneſs like the other Dimenſions, ſome not 1 Inch thick, and others 1 and a half thick; and by the way, I cannot forbear to mention one Caution in Ship-work; and that is, to have Deals of ſuitable Lengths for Bulkheads and Partitioning, ſince our common Height between

Deck and Deck is 7 Foot, and from that downwards to 5 Foot, and between ſuch Lengths may all Deals be tranſported, either of the equal Lengths, or double to ſuch Lengths; for Deals of 8 Foot, 9 Foot, nay 9 Foot and a half in Lengths are generally gilded and cut to Waſte; as in large Ships, which requires 7 Foot Lengths, there are 10 uſed for one in Ships that are 5 Foot high between Deck and Deck.

And ſuch Lengths or Heights between Deck and Deck will deſcend as low as 70 Gun Ships, nay in 50 Gun Ships (which will take in the ⅔ Part of the Navy) the Lengths will chiefly require to be 6 Foot long; and if they are not nicely converted, they may be moſt uſed for 5 Foot, and 5 Foot and a half Lengths.

The Rule then is thus, to ſee the ſolid Content in every Piece that the Meetings are over wide, the Cube Root of which ſolid Content ſhall adjuſt the Price of every Deal, as to what has paſſed. The ſolid Content in each Deal, will be as follows.

Inc. thick	Inc. broad	Length.	Solid Content	Cube of the Content.	d. Price per Foot running Meaſure.
4	15	32	13 1/3	2 1/4 1/5	10 1/4
3	14	23	6 7/10	1 8/10 8/100	8
2 1/2	13	17 1/2	3 95/100	1 5/10 8/100	6 3/4
2	12	13	2 17/100	1 3/10	5 1/4

Though this Calculation doth not exactly jump with the other, it will be near enough to adjuſt the Prices of ſuch Materials, nearer than ever they were adjuſted, and therefore I ſhall proceed to calculate ſomething farther of the Price and Value of ordinary Deals.

	Thick in Inch.	Inches broad.	Feet long.				Of a ſolid Foot.
Ordinary Deals	0 7/8	9	7	0 622/1728	or	0	2/10
	1	10	8	0 942/1728	or	0	5/9
	1 1/8	11	9	0 1332/1728	or	0	4/5
	1 1/4	12	10	1 22/1728	or	1	1/10
	1 3/8	13	11	1 522/1728	or	1	2/20
	1 1/2	14	12	1 1108/1728	or	1	3/4

		d. Value per Ft.	s. d. Price of each.	Cube Root in Inches.
The Cube Root of which is	0 3/4	2 3/4	1 2 1/2	8 1/4
	0 7/8	3	1 7 1/2	10
	1	3 1/4	2 2 3/4	11
	1 1/100	4	3 4	12 1/4
	1 10/100	4 1/4	4 3	
	1 2/10	4 3/4	5 6 1/2	

But our Cuſtomary Price for an ordinary Deal is generally at 12 *d.* each, but how far this Title extends itſelf is not certain; however, having more generally obſerved the Dimenſions of an ordinary Deal to be 10 Foot long, and 8 or 9 Inches broad, I ſhall ſet 12 *d.* on that Size, and ſee how the other Prices will aſcend or deſcend from that.

	Thick in Inch.	Breadth.	Length in Ft.	Cube of the ſolid Content in Feet and Inch: *Feet.*	*Inch.*	Value per Ft. *s.*	*d.*	Price of each ordinary Deal. *s.*	*d.*	*q.*
Ordinary Deals	0 7/8	9	7	0	8 1/4	1	2	0	7	3
	1	10	8	0	10	1	3	0	11	2
	1 1/8	11	9	0	11	2	0	1	4	2
	1 1/4	12	10	0	12 1/4	2	1	1	10	2
	1 3/8	13	11	1	1/10	2	2	2	6	0
	1 1/2	14	12	1	1 3/10	2	3	3	2	2

Theſe Prices are near the Cuſtom, and yet 4 times as dear in Proportion as the large Maſts are, ſince it's near 22 *d.* per ſolid Foot, and the large Maſts not above 3 *s.* 6 *d.* in the Medium, only here is Sawing to be conſider'd, which is look'd upon as very inconſiderable, in ſuch Saw-Mill Countries, and therefore I ſhall make one Calculation more from the Cube Root of the Content of *New-England* Maſts.

Ordinary

Ordinary Deals.

Inches thick.	Inches broad	Length in Feet	Cube of Content of the ſolid Feet in Feet, Inches & Parts. Ft.	Price per ſolid Foot. d.	Price of Sawing in each ſolid Foot. d.	Price of Timber and Sawing d.	Price of each Deal. d.
0 $\frac{7}{8}$	9	7	0 8 $\frac{1}{4}$	3	2	5	2
1	10	8	0 10	3 $\frac{1}{2}$	1 $\frac{1}{4}$	5 $\frac{1}{4}$	2 $\frac{1}{4}$
1 $\frac{1}{8}$	11	9	0 11	4	1 $\frac{1}{4}$	5 $\frac{1}{4}$	4 $\frac{1}{2}$
1 $\frac{1}{4}$	12	10	0 12 $\frac{1}{4}$	4 $\frac{1}{2}$	1 $\frac{1}{2}$	6	6 $\frac{1}{2}$
1 $\frac{3}{8}$	13	11	1 1 $\frac{1}{10}$	4 $\frac{3}{4}$	1 $\frac{1}{2}$	6 $\frac{1}{4}$	8 $\frac{1}{4}$
1 $\frac{1}{2}$	14	12	1 1 $\frac{2}{10}$	5 $\frac{1}{2}$	1 $\frac{1}{4}$	6 $\frac{3}{4}$	11 $\frac{1}{4}$

And this Calculation ſeems to Chalk out the Price of this ſmall Ware in the Deal Countries, and the Calculation preceeding this is near the Price they are in *England*; ſo that the Difference is what Advantage they make of ſuch Goods; notwithſtanding, my Deſign is not to inſtruct the World in fixing of direct Prices on Goods, and oblige all Times and Seaſons to my Calculations, but only to bring Prices to Generals, from the true Value of the Material, either from one known common Rule or other: Alſo to make obvious what Advantage may be made in fitly adapting the Material to the proper Service; which brings me to a Conſideration of one very material and uſeful Piece of Management in Shipping, and to ſhew what may either be prudently ſaved, or otherwiſe extravagantly expended in Sheathing of Shipping, and preſerving them from Worms; but firſt I ſhall juſt mention the Price of the Baulks and Uphirs.

Baulks and Uphirs from 30 Foot to 10 Foot long, and from 10 Inches to 3 Inches broad, at 15 *d. per* ſolid Foot, or 3 *l.* 2 *s.* 6 *d. per* Load, or 50 Foot. However, I ſhall conſider them ſeverally from the Lengths Contents and Area's.

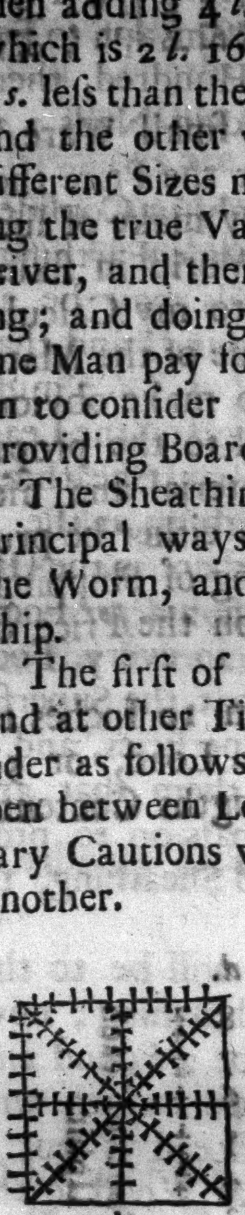
Feet long.	Inches Square.	Content in Feet and Parts.	Cube of the Content.	Value per Foot of each Baulk or Uphir. l.	s.	d.	Price of each Baulk or Uphir. l.	s.	d.	Value per Load of the Baulks and Uphirs. l.	s.	d.
30	10	21	2 $\frac{3}{4}$	0	1	8 $\frac{1}{4}$	1	15	5 $\frac{1}{4}$	4	3	11
28	9 $\frac{1}{2}$	17 $\frac{1}{2}$	2 $\frac{6}{10}$	0	1	7 $\frac{1}{2}$	1	8	5 $\frac{1}{4}$	4	1	3
26	9	14 $\frac{1}{2}$	2 $\frac{4}{10}$	0	1	6 $\frac{1}{2}$	1	2	9 $\frac{1}{4}$	3	17	1
24	8 $\frac{1}{2}$	12	2 $\frac{3}{10}$	0	1	5 $\frac{1}{2}$	0	17	6	3	12	11
22	8	10	2 $\frac{2}{10}$	0	1	4 $\frac{3}{4}$	0	13	6 $\frac{1}{2}$	3	7	8 $\frac{1}{2}$
20	7 $\frac{1}{2}$	8	2	0	1	3	0	10	0	3	2	6
18	7	6 $\frac{1}{4}$	1 $\frac{8}{10}$ $\frac{4}{100}$	0	1	1 $\frac{1}{4}$	0	7	2	2	17	3 $\frac{1}{2}$
16	6	4	1 $\frac{5}{10}$ $\frac{8}{100}$	0	1	0 $\frac{1}{2}$	0	4	2	2	12	1 $\frac{1}{4}$
14	5	2 $\frac{1}{2}$	1 $\frac{3}{10}$ $\frac{6}{100}$	0	0	10 $\frac{1}{4}$	0	2	2 $\frac{3}{4}$	2	4	9 $\frac{1}{2}$
12	4	1 $\frac{1}{3}$	1 $\frac{1}{10}$ $\frac{0}{100}$	0	0	8 $\frac{1}{4}$	0	0	10 $\frac{3}{4}$	1	16	5 $\frac{1}{2}$
10	3	0 $\frac{61}{100}$	0 [illegible]	0	0	7	0	0	4 $\frac{1}{2}$	1	9	2

The Medium Sum is 3 *l.* 0 *s.* 5 *d.* $\frac{1}{11}$, divided by the Number of Pieces per Load.

I have kept to the cuſtomary Price, as you may obſerve in the middle Article, where I deem a Baulk of 20 Foot long, and 7 Inches and a half Square, to be worth 3 *l.* 2 *s.* 6 *d. per* Load, or 1 *s.* 3 *d. per* ſolid Foot; but why ſuch a Price ſhould be made General for all theſe 11 Articles, I am next to Inquire; and in doing of it I ſhall firſt ſuppoſe, that a certain Number of the firſt ſized Baulks, and an equal Number to that of the laſt ſized Baulks, then adding, 1 *l.* 15 *s.* 5 *d.* ¼. and 4 *d.* ½. together, its 1 *l.* 15 *s.* 9 *d.* ¾. the Half of which is 17 *s.* 10 *d.* ¾. and the Price allowed in the General is but 10 *s.* each, as you may ſee in the middle Article; ſo that there is 7 *s.* 10 *d.* ¾ too much, according to that reckoning. Again, was there a certain Number of Loads of one ſort, and the other ſort which ſhould be equal in Number, then adding 4 *l.* 3 *s.* 11 *d.* and 1 *l.* 9 *s.* 2*d.* together, its 5 *l.* 12 *s.* 11*d.* the half of which is 2 *l.* 16 *s.* 5 *d.* ½ *per* Load, but the Price in the Medium is 3 *l.* 2 *s.* 6 *d.* 6 *s.* leſs than the juſt Value; ſo that one way the Loſs would be to the Merchant, and the other way to the Buyer; beſides the unequality in the Number of different Sizes nicely con'd over, would be found as deficient in nicely adjuſting the true Value of the Material, and doing Juſtice to the Vendor and Receiver, and therefore ſuch Materals cannot be nicely adjuſted by ſuch Lumping; and doing as I have often repeated in other Places, which is to make one Man pay for the Goods that another Uſes. I ſhall in the next Place paſs on to conſider of the Nature of Sheathing Ships, and to the Suitableneſs of providing Board for ſuch Work.

The Sheathing or Covering Ships under Water, may be conſidered two principal ways, one of which is to preſerve the Plank, and defend it from the Worm, and the other is to ſtrengthen and add to the Durableneſs of the Ship.

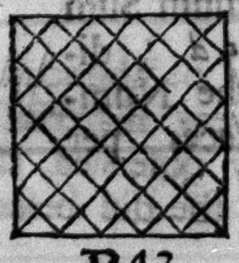
The firſt of which has been variouſly performed, at ſome times with Lead, and at other Times with Wood, term'd Sheathing Board, of which I ſhall conſider as follows; firſt, I ſhall draw a Parallel of the Charge which may happen between Lead and the Sheathing Board, and afterwards give ſome neceſſary Cautions what ought to be obſerved in working of it either one way or another.



A

Of Lead, the common Weight in a Foot Square is three Pound, and call'd thin Mill'd Lead, it being faſten'd with Copper Nails, that every Hundred may weigh 8 Ounces: I ſhall allow that the Copper Nails ſhall be put as thick as they are in the Figure A. which will be then 70 Nails in every Foot of Lead, which will weigh 5 Ounces and a half, at 19 *d. per* Pound, its 6 *d.* ¾. the Lead will be 3 *l.* at the Rate of 19 *s. per* Hundred, or near 2 *d. per* Pound, which is 6 *d.* the Foot, being put to 6 *d.* ¾. the Charge of the Nails, makes 1 *s.* 0 *d.* ¾. the Charge of every Foot of the Lead and faſtening of it, as to the Waſte it will at moſt looſe but 1 *s.* in every Hundred Weight.

The common Thickneſs of the Board uſed upon Ships, either little or big, is ¾ of an Inch thick; and as to the Length and Breadth it is always various, at ſome times broad, and very long, and at other times very narrow, but commonly broad, tho' the Reaſonableneſs of the ſaid Extreams I ſhall conſider of hereafter; but ſhall allow the Price of the Sheathing Board at the beſt Hand to be 2 *d.* ¼ *per* Foot, and the common Waſte being ⅓, which will be only Chips, then the Price will be 3 *d. per* Foot; the Nails that faſten being requiſite, as in the Figure B. 43. at 5 *d. per* Pound, or 10 *d. per* Hundred one with another, which will be 4 *d.* ¼. put to 3 *d.* the Charge of Board, it will be 7 *d.* ¼; but there will be ſome Difference in the Work, and pretty conſiderable too: However, I will allow but one Farthing in a Foot more to the Board Sheathing, which will then be 7 *d.* ½; ſo that the Difference at the firſt uſing will be 5 *d.* ¼ in every Foot that is uſed, which in the whole Ship will be more or leſs, according to the Number of Feet contained in the Superficies of the Ship under Water, or as high as the Ship is required to be Sheathed.



B43

I ſhall ſuppoſe that this Sheathing may continue 3 Years, without being pluck'd off again; and at the Expiration of that time it will be very proper to ſhift it, eſpecially the Board Sheathing, by reaſon the Length of the Nails will be more damnifying to the Ship's Plank than the Lead Sheathing Nails will; which Damage will aſſuredly cauſe ſuch Ships that are Sheathed with Wood Sheathing to be Sheathed again, ſince if the Plank be thin, and the Board the common Thickneſs, the Nail muſt be ſuitable to ſuch Thickneſs, and in ſome Meaſure damnify the Plank almoſt as much as the Worm: But to proceed, at the end of 3 Years the Sheathing is took off again, and the Board will be wholly loſt, fit for little but the Fire; perhaps ſome of it may be fitting for fencing, for which I ſhall allow One Farthing *per* Foot throughout, and the Nails, if they are wholly ſaved (which I am apt to believe they may) will be worth 1 *d.* $\frac{1}{2}$ *per* Pound, or 2 *d.* $\frac{1}{2}$ *per* Hundred, then there will be ſaved in every Foot of Wood Sheathing Board in Nails 1 *d.* and in Board 1 Farthing, which put together is 5 Farthings.

The Old Lead will be worth 15 *s. per* Hundred Weight, only in Conſideration of Waſting I ſhall allow but 13 *s. per* Hundred, which is 5 Farthings $\frac{1}{2}$ *per* Pound, and that is for 3 Pound 4 *d.* The Copper Nails may be as well ſaved as the Iron Nails, which will be worth 13 *d. per* Pound, and that for 70 will be 4 *d.* $\frac{1}{2}$, which added to 4 *d.* is 8 *d.* $\frac{1}{2}$; which Sum of 8 *d.* $\frac{1}{2}$ muſt be deducted out of 1 *s.* 0 *d.* 3 *q.* the Remains is 4 *d.* $\frac{1}{4}$, the Charge of the Lead *per* Foot at the end of three Years; now the Charge of the Wood Sheathing at the three Years end will be 6 *d.* $\frac{1}{2}$, ſo that the Wood Sheathing at the 3 Years end will be 2 *d.* $\frac{1}{4}$ dearer than the Lead Sheathing, only there is the Uſe of 5 *d.* $\frac{1}{4}$ for every Foot for three Years to be deducted out of the 2 *d. per* Foot, which will not be 1 *d.* ſo that the Lead Sheathing will be 1 *d.* in every Foot cheaper than the Wood Sheathing will be, which in a Ship that the Superficies is 5000 Foot, is 20 *l.* 16 *s.* 8 *d.* and as to Ships of bigger Superficies, and a large Number of them, I ſhall refer to the Conſideration of them that are immediately placed to adjuſt the Charge of fitting them, and paſs on to propoſe what Objections may be reaſonably made either to Wood Sheathing, or otherwiſe Ships that are Sheathed with Lead.

The firſt Objection I ſhall make againſt Wood Sheathing will be to the Weight, which will be much greater than that of the Lead Sheathing; now one Foot of ſolid Fir being 40 Pound, a Foot of $\frac{1}{4}$ broad will be 2 Pound and Quarter, and the Nails Weight to the Wood will be as 7 to 10, which will be 1 Pound $\frac{1}{4}$, and together will be 4 Pound. The Foot of Lead is but 3 Pound, and the Nails 5 Ounces and a half; then the Weight of Wood to the Weight of Lead is as 16 to 15; and as Gravity is Reſiſtance to the Motion of the Ship, this over-weight in a large bodied Ship will be a great Hinderance.

The ſecond Objection will be ſtill worſe, and that is as to the Thickneſs of the Board to the Thickneſs of the Lead, which will be at leaſt as 12 to 1, and ſo the Reſiſtance will be; that the different Reſiſtance will be according to the Compound Fraction $\frac{15}{16}$ added to $\frac{1}{12}$, which together is $\frac{16}{192}$.

And this Faculty will be ſtill made worſe through the Irregularity of the Board, and Ductileneſs of the Lead, which may be put on upon the Ship as ſmooth and even and in as good Order as the very Figure of the Ship was in its Natural Poſition.

Indeed I cannot ſay but that the Wood Sheathing may be abundantly better perform'd than is generally ſeen, which would be very material in Sheathing the *Weſt-India* Cruiſing Ships, ſince its generally obſerved, that ſcarce any Ship ſails ſo well by far after ſhe is Sheathed, as ſhe did before; a Method for doing the ſame I ſhall hereafter deſcribe.

The third Objection is in the driving long Nails to faſten the Sheathing Board, which eſpecially in thin Planks (that is on ſmall Ships and Veſſels Bottoms) ſplits the Plank to Pieces, and cauſes Leakage; a Caution which

I ſhall more particularly give, when I come to the Sizing of the Sheathing Board, and ſhall proceed to ſhew the Objections which may be reaſonably made againſt Lead Sheathing.

The firſt Objection is, that the Lead will corrode and deſtroy the Iron that lyes under it, and having ſpoke particularly to that in the beginning of this Treatiſe, I ſhall ſay nothing of that Nature here, only ſhew, if it be ſo, how it may be prevented; whereas in the Floor Rider Bolts that are covered with Lead, it's now found that the Bolts are ſo little eaten, that the cuſtom is not left off, but all Bolts that are drove outward and clench'd, are cover'd with Lead, without any thing between, except a little Hair.

And again, the Bolts that are drove in the Keel, that never had any Lead put near them, are as often eat as any other Bolts whatever; but let the caſe be ſo ſtated, that the Lead Sheathing would eat the Iron, as more particularly the Ruther Braces and Pintels, then ſuch Parts may be left bare, for the Worm cannot eat Iron; or otherwiſe there may be tarr'd Canvas double or treble put between the Lead and the Iron, which will undeniably preſerve it and keep it from being eat.

The ſecond Objection againſt Lead Sheathing is, that it will ſoon be rubb'd off, and ſo become uſeleſs: This may eaſily be prevented, by Sheathing with Wood at the Waters Edge, and 1 Foot below it; and alſo above the Water; and in grounding it's only placing a very ſlender well ſhaped Piece of Fir or Elm on the Veſſels Bulge, which will take the Ground, and ſecure the Bottom Sheathing from being rubb'd off.

And after all ſuch Pro and Con, for and againſt Lead Sheathing, I would not have any one to believe I am bigotted to an Opinion for having all Ships Sheathed with Lead, but am only ſhewing the Advantage or Diſadvantage which will happen by the Uſe of ſuch Materials, and therefore ſhall ſhew my Opinion how the Management in Sheathing with Wood may be much amended.

Firſt, I would have no new Ship ſheathed, ſince the Nails will undeniably Damage the Plank, and then let the Duration of a Ship be 20 Years, ſhe muſt during all that time be kept continually ſheathed

But when there is Neceſſity to ſheath a Ship or Ships for ſuch Foreign Voyages, in which the Worms will be ſure to eat and corrode the Planks, then ſuch Ships may be taken as are wholly deſigned for ſuch Voyages, and then their Sheathing will be ſucceſſively repaired as the Needfulneſs and Neceſſity of the thing doth require; and that the ſaid Sheathing may be fitly adapted for the Ship, I ſhall conſider the Thickneſs of the Sheathing Board agreeable to the Thickneſs of the Plank it is Nail'd to, that the Length of the Nail may be in every reſpect agreeable both in Length and Bigneſs to the Thickneſs of the ſaid Plank.

The Cuſtom has been to allow a ¾ Sheathing to cover a four Inch Plank, and then the Length of the Nail ought to be 2 Inches; but in Conſideration that the Hair may keep the Board off a Quarter of an Inch, I ſhall put that Quarter to the Thickneſs of the Board, and then the Length of the Nail will be 2 ⅝; ſo that 1 Inch and ⅝ will pierce into the Ships Plank, and will be ſufficient, provided the ſaid Work be well and nicely performed.

Inch. Plank.	Thickneſs of the Sheathing Board in Parts of an Inch.	Thickneſs of the Hair.	Thickneſs of the Tar and Hair.	*Inch.* Length of Nail in the Plank.	*Inch.* Whole Length of the Nail.	Part of the Plank that the Nail don't affect.
4	¾	¼	1	1 ⅝	2 ⅝	2 ⅜
3	$\frac{9}{16}$	$\frac{3}{16}$	¾	1 $\frac{3}{16}$	1 $\frac{15}{16}$	1 $\frac{13}{16}$
2 ½	$\frac{15}{32}$	$\frac{5}{32}$	⅝	1	1 ⅝	1 ½
2	⅜	⅛	½	0 $\frac{13}{16}$	1 $\frac{5}{16}$	1 $\frac{3}{16}$

And this Calculation I am poſitive would be Hebrew to moſt of our Ship-wrights, to know how theſe Nails would be made ſuitable and ſufficient for the Work, ſince it's often obſerved, that the Workmen will drive Nails of double ſuch Length for what they term drawing the Board to the Work; and ſo perhaps could one ſee the inſide of the Ship, you might obſerve Hundreds of Nails quite through, ſo that nothing can ſcarce make the Ship Swim, but what makes Coopers Ware hold Liquor, and that is to put it into the Water till the Pores of Wood are fill'd, which forces the Crannies to cloſe together, otherwiſe the Ship or Veſſel would undeniable ſink.

But perhaps it will be expected of me to deſcribe a Method how this Work ſhall be done, as well as to calculate Tables of the Size of the Material to perform it, the which I ſhall proceed to ſhew in the next Place.

Firſt, I proteſt againſt having long Sheathing Board, not only from the different Price there is between that and ſhort; but as I have often obſerved in Sheathing, becauſe the Workman in his hurry to get out of a dirty Job, tacks up a long Board, and whether it ſuits to the other Edges or not, he will force him with Nails; and this is one great Fault that requires ſuch long Nails, to do that which ſhorter Nails would every whit as well do, with a little more Care and Pains.

I have ſeen Fir Timber near 18 Inches Square and 40 Foot long, cut for Sheathing Board, the Content of which is 90 Foot, and Cube of the Content 4 $\frac{1}{2}$, the Value *per* Foot will be 1 *s.* 8 *d.* $\frac{1}{2}$ as rough Timber; and Timber at the ſame time at hand of 18 Foot long and 10 Inches Square, the Content of which is 12 Foot $\frac{1}{4}$, and Cube of the Content 2 $\frac{3}{10}$, Value *per* Foot 10 *d.* $\frac{1}{2}$. near half as much; but then I know ſome will be apt to object, that one of the large Boards will be equal to 4 of the other ſhort ones, and of conſequence will be wrought much ſooner and cheaper: This I ſhall allow, if the Work is done as cuſtomary; but if it be well done, with Nicety in the Performance, the ſhort Boards will as ſoon Cover a Ship as the large ones.

I muſt confeſs the Intervals in bringing the Boards to the Work will be as 4 to 1, but then that one Interval which is required to bring the large Board to nicely, may be full in the ſame Proportion as 4 to 1; ſince the large Boards will be very unhandy and troubleſome to work, eſpecially when it's laid with ſuch a ſurfeiting Material as Tar and Hair, which no Mortal can ſcarce be able to touch.

Again, the Waſte will be much leſs, ſince Fir Timber is generally ſtraight, and no Part of a Ship is directly ſo except in the Midſhips, and Fir will not bear bending Edge-ways, without running the hazard of tearing it to Pieces; therefore the ſhort Lengths will be more ſuitable for ſuch Variety in bending, and conſequently will be wrought with leſs Waſte.

But fearing I ſhould be miſunderſtood here, and condemned for allowing ſtraight edg'd Plank, moſt ſuitable for covering Ship's Timber, and denying ſtraight Sheathing Board to correſpond to the Plank; but to that I ſhall ſay, that there is a vaſt Difference between 40 Foot and 24 Foot; for if a Plank was to be crooked 2 Inches in 20 Foot, it would require 8 Inches bending in 40 Foot; and farther I preſume, that the Artifice required to bend a 4 Inch Plank 8 Inches from any Poſition, would be but very little more than what would be required to bend a Sheathing Board of $\frac{3}{4}$ of an Inch thick, and the Length and Breadth ſuitable with the Plank. Theſe Conſiderations, and ſome others, being duely premiſed, would put us upon Thoughts how to perform this moſt Material Branch of Sheathing Ships, both with Advantage to the Workmanſhip, and alſo to the Material.

There might perhaps be a weak Objection made againſt Sheathing Ships with ſhort and narrow Sheathing Board, that ſcarce one able Workman in five would be able to perform ſuch a Piece of Service nicely, which I believe to be true, and perhaps there might be wanting an Able and Experienc'd Quarter-man, that knows how to ſhift Work, and make it good with 24

Foot

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Inch.				Inch.	Inch.	
Plank.	Thickneſs of the Sheathing Board in Parts of an Inch.	Thickneſs of the Hair.	Thickneſs of the Tar and Hair.	Length of Nail in the Plank,	Whole Length of the Nail.	Part of the Plank that the Nail don't affect
4	$\frac{3}{4}$	$\frac{1}{4}$	1	1 $\frac{5}{8}$	2 $\frac{5}{8}$	2 $\frac{3}{8}$
3	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{4}$	1 $\frac{3}{16}$	1 $\frac{15}{16}$	1 $\frac{13}{16}$
2 $\frac{1}{2}$	$\frac{15}{32}$	$\frac{5}{32}$	$\frac{5}{8}$	1	1 $\frac{5}{8}$	1 $\frac{3}{8}$
2	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{1}{2}$	0 $\frac{13}{16}$	1 $\frac{5}{16}$	1 $\frac{3}{16}$

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I muſt confeſs the Intervals in bringing the Boards to the Work will be as 4 to 1, but then that one Interval which is required to bring the large Board to nicely, may be full in the ſame Proportion as 4 to 1; ſince the large Boards will be very unhandy and troubleſome to work, eſpecially when it's laid with ſuch a ſurfeiting Material as Tar and Hair, which no Mortal can ſcarce be able to touch.

Again, the Waſte will be much leſs, ſince Fir Timber is generally ſtraight, and no Part of a Ship is directly ſo except in the Midſhips, and Fir will not bear bending Edge-ways, without running the hazard of tearing it to Pieces; therefore the ſhort Lengths will be more ſuitable for ſuch Variety in bending, and conſequently will be wrought with leſs Waſte.

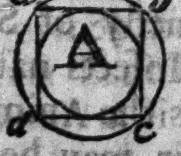
But fearing I ſhould be miſunderſtood here, and condemned for allowing ſtraight edg'd Plank, moſt ſuitable for covering Ship's Timber, and denying ſtraight Sheathing Board to correſpond to the Plank; but to that I ſhall ſay, that there is a vaſt Difference between 40 Foot and 24 Foot; for if a Plank was to be crooked 2 Inches in 20 Foot, it would require 8 Inches bending in 40 Foot; and farther I preſume, that the Artifice required to bend a 4 Inch Plank 8 Inches from any Poſition, would be but very little more than what would be required to bend a Sheathing Board of $\frac{3}{4}$ of an Inch thick, and the Length and Breadth ſuitable with the Plank. Theſe Conſiderations, and ſome others, being duely premiſed, would put us upon Thoughts how to perform this moſt Material Branch of Sheathing Ships, both with Advantage to the Workmanſhip, and alſo to the Material.

There might perhaps be a weak Objection made againſt Sheathing Ships with ſhort and narrow Sheathing Board, that ſcarce one able Workman in five would be able to perform ſuch a Piece of Service nicely, which I believe to be true, and perhaps there might be wanting an Able and Experienc'd Quarter-man, that knows how to ſhift Work, and make it good with 24

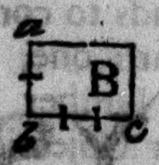
Foot Lengths; but I am well aſſured, that a great many experienc'd Men would, with ſome Conſideration, make as good Work with 10 Foot Boards, as I have ſeen done with 30 Foot Lengths, and bring their But-ends to comply every way a advantagious to Sheathing the Ship as well with one, as has been done with the other, and the Difference in Time and Number of Men ſhall be but very ſmall; which brings me to Anſwer another Objection that I believe may be made againſt my Calculation.

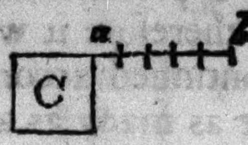
The laying the Hair to a true Gauge, ſmooth and even, I preſume will be highly objected againſt as a vaſt Hinderance in Time, and therefore it will be rather allowed, that this Part in the Sheathing ſhall be continued according to the ancient Cuſtom, which is for two or three Men, or as many as are upon one Length of Board, to Tar the Board, and then dab on the Hair ſo very confuſed, that in ſome Places it ſhall be half an Inch thick, and in other Places never a Hair; ſo that in Nailing, the Board ſhall either be kept off by ſuch irregular heaps of Hair, or otherwiſe be ſplit to Pieces in drawing the Board cloſe to the Plank; which brings another Thought to my Mind, and that is in what is called Sizing of Seams with Spun Yarn, which has no other Notice taking of it than this, That there be the ſame Part of the Yarn in every Seam, whether the Seam will receive it or not, and ſo the Yarn that projects (by being put to a Seam that will not receive it, or otherwiſe that the Yarn is bigger in one Place than another) will alſo keep the Board off, and beget a Hollowneſs in the Work, which will be extreamly prejudicial; and therefore, in my Opinion, a little Time, or allowing a Farthing in a Foot Difference to the Labour, all ſuch careleſs Performance might be amended, and the Ship a Penny in every Foot of Sheathing the better, both in the Durableneſs of the Sheathing upon the Ship, and in preſerving the Plank much better whilſt it remains upon her.

I ſhould therefore give my Opinion thus; That if the Hair could be put on upon the Ship after the Board is nicely and exactly fitted, and the Ship tarr'd in the Wake of ſuch a Board, it might be put on much better and ſmoother; for when the Hair is put upon the Board, in raiſing the Board upon the Edge, and clapping it on the Ship, half the Hair is ſcatter'd, and ſo becomes of no Service, except to the Bottom of the Dock.



I would have all the Holes bored with a Piercer, or Gimblet; eſpecially at the Board's Ends and Edges; ſince it muſt needs be allowed, that in driving all Nails, the Wood is either carried before the Point of the Nail, to make a vacant Place for him, and ſo becomes Chips on the Inſide, and decaying; or otherwiſe the Board muſt ſplit to make a Hole for the Nail that way; and therefore it's highly prejudicial to have any manner of Nail drove into any Part of a Ship, without boring a Hole to receive him, with a Gimlet ſuitable, not much too little, nor be ſure nothing too big; for if it be too big, as you may obſerve in the Figure *A.* by the Square *a. b. c. d.* Suppoſing the Square *a. b. c. d.* to be the Bigneſs of a Nail at the biggeſt Place, and you was to bore a Hole for ſuch a Nail with a Gimblet, whoſe Diameter ſhall be equal to the Diameter of the outer Circle, than only the Extreams or Corners of the Nail would touch the ſides of the Hole ſo made with the Gimblet: But on the other Hand, if the Gimblet's Diameter was equal to the Diameter of the little Circle, then all the Corners of the Nail would be more than the Bigneſs of the Hole, and ſo cauſe a Stifneſs in the Drift, which in fine tender Work would be a ſuitable ſized Gimblet for a Nail, whoſe Area would be equal to the Square *a. b. c. d.* and ſo the ſide of the Nail (provided it was duly right ſquar'd) would be exactly equal to the Diameter of the Gimblet, as in the Figure, the Diameter of the inſcribed Circle ſhall be a ſuitable Gimblet for a Nail whoſe Bigneſs in the biggeſt Part, will be equal to the Square *a. b. c. d.* But in rude hard Work I have obſerved theſe Sizes will not agree to uſe; but the Gimblet will be ſtill too big for the Nail. And having obſerved that ſlat pointed Nails are alſo made Oblong, as in the Figure *B*, the Side *a. b.* ſhall be 2 Parts of the Side *b. c.* and the Gimblet's Diameter ſhall be ſizeable when it's equal to the ſmalleſt Side *a. b.* and will drive a Nail of ſuch a Size very ſtiff and very well; ſo that in caſe a Nail be duly Square, as in the Figure *C*, and required to be drove into hard Work, then vulgularly with your Compaſſes, take the Side of the Square, and ſet that Diſtance off twice from *a.* to *b.* divide the Line *a. b.* into 5 equal Parts, and 2 of ſuch Parts ſhall be the Diameter of a Gimblet, ſizeable for to drive a Nail of the Bigneſs of the Square *C.* Notwithſtanding there will be Varieties of Conſiderations requiſite in the Uſe of Gimblets, with divers ſhaped Nails, and in divers Jobs; but what I have mentioned here is more General than any other, and therefore I ſhall paſs this Conſideration with only mentioning, that if the Work to be faſten'd is over hard, and the Nail put to pierce itſelf, without the Aſſiſtance of a Gimblet, the Point of the Nail ought to be made ſtiffer than they are generally obſerved, to force the Wood, and make room for the Body of the Nail that follows the ſaid Point; otherwiſe it may, as it often doth, happen, that the Point, not being able and ſufficient to reſiſt and clear the Wood which oppoſes it, will bend double, and hinder inſtead of aſſiſting and forwarding the Drift of the Nail.





Here is ſtill another Objection which I expect to be made againſt my Calculation, and that is to the Thinneſs of the Board; that ¾ of an Inch Board will not be ſufficient to defend the Worm from the Plank, or that it will not bear of being Calked.

As to the Calking Part, it's not much matter whether it's Calked or not, ſince it may as well be Cypher'd one Edge over another, for the Calking is but of little Service in the ¾ Board.

And as for the Defence againſt the Worms eating, it's Notional, ſince I have ſeen a Ship's Sheathing perfectly Honey-Comb'd; for it's the Opinion of moſt, that the Worms will eat through the Sheathing Board until they come to the Tar and Hair, which turns the Inſect, as believing that Ingredient is offenſive to the Worm; indeed then it muſt be the Hair, ſince the Creature muſt firſt eat through Pitch before it comes to the Board, which is all one as if he had eat through Tar.

Others will tell you, that this ſaid Animal will eat through the Ship's Plank, tho' it be 4 Inches thick, and as ſoon as he finds himſelf through, he will naturally turn and eat in the Plank Length-ways; but this is as long as the Ship continues in Salt Water; for if there ſhould chance to be any Worms in a Ship or Veſſel, and the ſaid Veſſel happen to go into freſh Water, they would immediately eat through, and ſo ſink the Ship or Veſſel, as has been formerly experienc'd in *Virginia*, where their Rivers conſiſt chiefly of Salt Water and freſh; from which it may be obſerved, that theſe Inſects nauſiate the freſh Water: Well then, if it be only the Hair that ſtops the Animal, it may be as well done with ¼ Board as ¾ Board, ſince the Hair may be as well and better laid under thin Board, than it has been general to lay it under thick; however, it has been experienc'd, that the Ship's Planks have been eat in ſeveral Places under the Sheathing, where the Worm has eat much, and through the Board; which, if the Hair is offenſive, and Proof againſt the Worm, the damnify'd Plank muſt be owing to Neglect, in not laying ſufficient Hair in the Wake of every Part of the Board.

Thus much I have obſerved in *Virginia*, where in the Heat of Summer the Worm eats terribly, inſomuch, that I was obliged to clean our Ship and Boats very often, and yet the Boats Bottoms were perfectly eat to Pieces, and the Ship's Sheathing was miſerably eat, not only at the Water's Edge but quite to the Keel, nay downwards moſt; for undeniably often cleaning the Ship upwards, and the Advantage of a Flux, or the Motion of the Ship, is a great Preſervative, which will effect the Ship moſt near the Surface of the Water.

OF BLOCKS, *or* PULLEYS.

	Size.	Wood Blocks.				Value.	
		Single.		Double.		Treble	
	Inches.	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Elm Blocks.	40 to 27	2	6	6	0	7	6
	36 to 33	2	4	4	8	7	0
	32 to 31	2	3	4	6	6	9
	30 to 29	2	2 ½	4	5	6	7 ½
	28 to 27	2	1 ¼	4	3 ½	6	5 ¼
	26	2	0	4	0	6	0
	25	1	11 ¼	3	11 ½	5	11 ¼
	24 to 23	1	10	3	8	5	6
	22 to 21	1	9	3	6	5	3
	20 to 19	1	8	3	4	5	0
	18 to 17	1	7	3	2	4	9
	16	1	6	3	0	4	6
	15 to 14	1	4	2	8	4	0
	13	1	1	2	2	3	3
	12	0	11 ½	1	11	2	10 ½
	11 to 10	0	11	1	10	2	9
	9	0	10	1	8	2	6
Ash or Elm Blocks.	8 to 7	0	9	1	6	2	3
	6	0	8	1	4	2	0
	5 to 3	0	8	1	4	2	0

And these Prices are set and adjusted by measuring only the Length, which they call so many Inches Running Measure.

Elm

Wood Blocks.

Sizes.	Racking-Head.		Voyal.		Launching.	
	Value each.					
	Single.		Double.		Treble.	
Inches.	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
72 to 70	2	0	3	10	3	0
69 to 67	1	11	3	9	2	11
66 to 63	1	10	3	8 ½	2	10
62 to 58	1	9	3	8	2	9 ½
57 to 50	1	7	3	7 ½	2	9
49 to 46	1	6	3	7	2	8
45 to 43	1	5	3	7	2	8
42 to 41	1	4				
40 to 36	1	4	3	6 ½	2	7
35 to 32	1	3	3	6	2	6
31 to 30	1	3	3	0	2	6

And theſe Prices are ſet and adjuſted by meaſuring only the Length, which they call ſo many Inches Running Meaſure.

Lignum-vitæ Shivers are generally for 5 *d.* per Pound,

Dead

Dead Eyes of Aſh or Elm for Stay-Shrowds.

	Size.	Value.			Size.	Value.	
	Inches.	*s.*	*d.*		*Inches.*	*s.*	*d.*
Aſh or Elm	30	3	0	Aſh or Elm	15 to 14	1	3
	29 to 28	2	10			1	2
	27 to 26 to 25	2	8		13 to 12	1	0
	24	2	6			0	11
	23 to 21	2	6		11 to 12	0	11
	20 to 18	2	0		9	0	01
	17 to 16	1	8		8 to 7	0	9
		s.	*d.*		6 to 5	0	8
		1	4		4 to 3	0	7

And these Prices are let for each reſpective Dead-Eye, according to the reſpective Diameter.

The Price of Elm and Aſh Parrels compleat.

	First Rate.		Second Rate.		Third Rate.		Fourth Rate.		Fifth Rate.		Sixth Rate.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Main	18	0	16	0	14	0	11	0	8	0	6	0
Fore	16	0	14	0	11	0	8	0	6	0	5	0
Main Top-maſt	8	0	6	0	5	0	5	0	4	6	3	6
Fore Top-maſt	6	0	5	0	5	0	4	6	3	6	3	0
Mizon	8	0	6	0	5	0	5	0	4	6	3	6
Main / Fore Top Gallant-maſts	3	6	3	0	2	8	2	0	2	0	1	6
Spritſail and Mizon Top maſt	3	0	2	8	2	0	2	0	1	10	1	5

	s.	d.	
Small Globe Balls under 2 Inches and a half	0	2	each:
Turn'd Balliſters under 3 Foot long	0	1	perFoot.
Aſh Brakes for Pumps: From 7 Ft. to 6 Ft. long	1	0	each.
Aſh Brakes for Pumps: From 9 Ft. to 5 Ft. long.	0	11	each.
Capſtand Bars 5 Inches Square	0	5	perFoot.
Wood Commanders 14 Inches long, 10 deep and 9 thick	1	6	each.

			s.	d.	
Aſh Fids for	Fore Topmaſts		1	6	each.
	Fore Top Gallant-maſts		0	5	
	Splicing		1	0	
Handles for Two-hand Saws			0	0½	each.
Helves for reeming Beetles			0	3	
Lignum-vitæ Shivers and Granaditian			0	5	per *l.*
Live Oak Pins			0	5	
Turn'd Hand-ſpokes	Birch 6 or 7 Ft. long		0	8	each.
	Aſh		0	10	
	Aſh 7 Ft. and a half long		0	12	
	Birch		0	9	
Serving Maulets			0	8	each:
Fir Oars for Long-boats, double Banked 15 and 16 Ft. long			0	2	per Ft.
For Turning of Pillars of the ſeveral Lengths	7		2	2	each.
	6		1	6	
	5 Foot long		1	0	
	4		0	6	
	3		0	3	
For Turning of Pins			1	6	perDoz
For Chain Pumps without Heads, excepting all Iron-work, but Spikes and Nails,	Firſt Size	3	7	6	each.
	Second Size	3	7	6	
	Third Size	3	0	0	
	Fourth Size	3	0	0	
	Fifth Size	2	5	0	
For Chain Pump Wheels		0	3	0	each.
For Pump Dales			1	3	per Ft.
For Caſes, finding Nails for fourth and fifth Rates			7	9	each.
Upwards of that Size			14	0	
For Heads			4	6	

		For Leather.		Workmanſhip.		
		s.	d.	s.	d.	
Firſt and Second	Upper Deck	17	0	5	0	
	Lower Deck	13	0	4	0	
Third Rates		11	0	4	0	
Fourth Rates		10	0	4	0	
Fifth Rates		08	0	3	6	
For the Workmanſhip in Leathering Chains				3	0	
For ſmall Wooden Pumps				2	6	each.
For Heading Pumps				2	4	
Hand-Pumps	from 8 Foot to 4 Foot long			1	3	per Ft.
	from 15 Ft. to 18 Ft. long			1	6	
	from 19 Ft. to 26 Ft. long			2	0	
	from 27 Ft. to 31 Ft. long			2	6	
Boxes	Clap'd			0	1	
	Long			1	0	each.
	Short			0	5	
	Leather'd, finding Leather			1	0	
	Ditto, only Workmanſhip			0	2½	
Whipſtaff Rowels	For firſt and ſecond Rates			5	0	
	For third Rates			4	0	each.
	For fourth Rates			3	0	
	For fifth Rates			3	0	
Rowels of Lignum-vitæ for Boats Heads				0	5	per *l.*

Item	Particulars			s.	d.	
Shivers let into Timber Heads				0	3	each.
Shivers let into Jeer-Bits, Topſail-ſheets, Snatch-Blocks and Cat-Rope Falls				0	6	Pound.
Wood Supporters for Lanterns	For firſt and ſecond Rates			4	0	each.
	For third Rates			3	6	
	For fourth Rates			2	6	
	For fifth Rates			1	6	
Tops of Elm and yellow *Pruſſia* Deal, compleat except Reem Plates	From 4 Ft. to 6 Ft. ½ Diameter			3	6	per Ft.
	From 7 Ft. to 9 Ft. ½ Diameter			4	0	
	From 10 Ft. to 13 Ft. ½ Diameter			5	2	
	From 14 Ft. to 16 Ft. ½ Diameter			6	3	
	From 17 Ft. to 18 Ft. Diameter			8	0	
Aſh Top Hoops	15 and 16 Foot long			2	0	each.
	12, 13 and 14 Foot long			1	8	
	11 and 10 Foot long			1	6	
Thoals of all ſorts				1	0	perDoz
Trucks of Wood	Of 16 Inches and 15	Inches Diameter	5½ Thick	1	10	each.
	Of 14 Inches and 13		5 Thick	1	5	
	Of 12 Inches and 11		5 Thick	1	2	
	Of 10 Inches 9 and 8		4½ Thick	0	9	
	For Vane Spindles			0	4	
	For Shrouds			0	2	
Whirls for Rope makers	Laying			0	6	
	Spinning			0	3	
Whip-Staffs	For firſt Rates			5	0	
	For ſecond Rates			4	4	
	For third Rates			3	9	
	For fourth Rates			2	6	
	For fifth Rates			2	0	
	For ſixth Rates			1	6	

Item	Particulars	Inch.	s.	d.	
Blocks Shoulder'd	For Yard Arms	14	2	0	per Ft.
		13	1	11	
		12	1	6	
		11	1	6	
		10	1	4	
		9	1	2	
		8	1	0	
	For Clew Garnets	15	2	4	
		14	2	4	
		13	2	0	
		12	2	0	
		11	1	8	
		10	1	8	
		9	1	4	
		8	1	0	
		7	1	0	
Aſh Shivers for old Blocks	From 20 Inches to 16 Inches		1	6	each.
	From 15 Inches to 12 Inches		1	0	
	From 11 Inches to 9 Inches		0	7	
	From 8 Inches to 6 Inches		0	5	
	From 5 Inches to 3 Inches		0	3	
Holly Pins for	Single Blocks of all Sizes		1	6	
	Double Blocks of all Sizes		3	0	
	Treble Blocks of all Sizes		4	6	

Length

	Inch.
Length of one Block	8
Breadth of it	7
Shiver Hole	1¼
Cheeks of each	1⅜
Shiver Diameter	5
Ditto thick	1⅛
Whole Thickneſs	3¾
The Pin-hole	1

Proportion of the

Length to Breadth as	8 to 7
Length to Thickneſs as	15 to 7
Breadth of the Blocks to the Diameter of the Sheave as	7 to 5
Diameter of the Sheave to the Thickneſs as	31 to 7
Shiver-hole's Thickneſs to the Waſte on each ſide or Cheeks as	10 to 11
Shiver-hole to the Shiver as	10 to 9
Pin's Diameter to the Length of the ſame as	1 to 5

	Inch.
Another Block's Length	8
Breadth	6
Shiver-hole	1⅛
Cheek of each ſide	1⅛
Diameter Shiver	5
Ditto thick	1
The whole Thickneſs	3¼
The Pin-hole	0⅞

Proportion of the

Length to Breadth as	4 to 3
Length to Thickneſs as	5 to 2
Breadth of the Block to the Diam. of the Sheave as	6 to 5
Diameter of the Sheave to the Thickneſs as	5 to 1
Shiver-hole's Thickneſs to the Waſte or Cheeks as	1 to 1
Shiver-hole to the Shiver as	9 to 8
Pin's Diameter to the Thickneſs of the Block or Length of the Pin.	7 to 40

This ſeems to be the beſt Size.

	Inch.
Another Block's Length	13
Breadth	11
Diam. of the Sheave	9
Thickneſs of the Sheave	1⅜
Breadth of the Hole	1½
Cheeks of each ſide	1¾
Pin Diameter	1¼
Length of Pin, or whole Thickneſs of the Block	5

Proportion of the

Length to Breadth as	13 to 11
Length to Thickneſs as	13 to 5
Breadth of the Block to the Diam, of the Sheave as	11 to 9
Diameter of the Shiver to the Thickneſs as	20 to 3
Shiver-hole's Thickneſs to the Waſte or Cheeks as	6 to 7
Shiver-hole to the Shiver as	10 to 9
Pin's Diameter to the Length of the ſame as	2 to 9

	Inch.
Another Block's Length	13
Breadth	11
Shiver hole	1½
Cheeks or Waſte	1½
Shivers Diameter	8½
Thick ditto	1⅜
Pin's Diameter	1⅜
Length of ditto or thickneſs of the Block	4⅕

Proportion of the

Length to Breadth as	13 to 11
Length to Thickneſs as	20 to 7
Bread of the Block to the Diameter of the Shiver	9 to 7
Diam. of the Shiver to the Thickneſs	25 to 4
Shiver-hole's Thickneſs to the Waſte or Cheeks	1 to 1
Shiver-hole to the Shiver	10 to 9
Pin's Diameter to the Length or Thickneſs of the Block as	3 to 10

Another

	Inch.
Another Block's Length	12
Breadth	9
Shiver-hole	2
Cheek of one ſide	1½
Of the other ſide	2
Diameter of the Shiver	7
Thick ditto	1⅞
Pin's Diameter	1⅜
Length of ditto or Thickneſs of the Block	5½

Proportion of the

Length to Breadth as	4	to	3
Length to Thickneſs as	11	to	5
Breadth of the Block to the Diameter of the Shiver as	9	to	7
Diameter of the Shiver to the Thickneſs as	15	to	4
Shiver-hole's Thickneſs to the Waſte or Cheeks	Various.		
Shiver-hole to the Shiver as	15	to	14
Pin's Diameter to the Length or Thickneſs of the Block as	1	to	4

And here will be Inſtances enough of this kind, to ſhew the various Dimenſions of ſuch Blocks, as are more commonly uſed than any other; ſo that I ſhall paſs on at preſent to ſhew the Dimenſions of ſome others, as Double and Treble Blocks; alſo of ſuch as are not ſhaped or bound with Ropes.

Double and Treble Blocks are ſuch as have Double or Treble Shiver-holes, otherwiſe their Shape is the ſame; but the Faſhion or Manner of making them is as follows.

Length of a Double Block	13
Breadth	11
Shiver-holes	1½
Intervals	⅞
Cheeks or Waſte	1⅞
Shivers Diameter	8½
Thick	1⅜
Pin's Diameter	2⅝
Length of ditto, or Thickneſs of the Block	7⅝

Proportion is

Length to Breadth as	13	to	11
Length to Thickneſs as	12	to	7
Breadth of the Block to the Diameter of the Shiver as	9	to	7
Diameter of the Shiver to the Thickneſs as	25	to	4
Shiver-hole's Thickneſs to the Waſte or Cheeks	4	to	5
Shiver-hole to the Shiver as	10	to	9
Pin's Diameter to the Length or Thickneſs of the Block as	4	to	19

Length of a Treble Block	13
Breadth	11
Shiver-hole	1½
Intervals	⅞
Cheek or Waſte	2
Diameter of the Shiver	8½
Thick	1⅜
Pin's Diameter	1⅞
Length of the Pin, or Block's Thickneſs	10¼

Proportion is

Length to Breadth is as	13	to	11
Length to Thickneſs as	9	to	7
Breadth of the Block to the Diameter of the Shiver as	9	to	7
Diameter of the Shiver to the Thickneſs as	25	to	4
Shiver-hole's Thickneſs to the Waſte or Cheeks	3	to	4
Shiver-hole to the Shiver as	10	to	9
Pin's Diameter to the Length or Thickneſs of the Block	2	to	13
Intervals to the Bigneſs of the Shiver	7	to	11

From which you may obſerve, that if the Lengths of Blocks are the ſame, whether they be Single, Double or Treble, the Breadth is alſo the ſame; but the Thickneſs of Double to Single is as 3 to 2, which is $\frac{1}{2}$ more, and in Treble it's as 2 to 1. The Workmanſhip in cutting the Shiver-hole is according to the Number of Shivers, but the Work of ſhaving or ſmoothing their Outſides is equal, conſidering the Charge of Converſion in Sawing more in ſmall Blocks than in thoſe that are bigger, for the Timber muſt be every whit as Valuable to make Single Blocks as Treble ones of equal Length.

I am of Opinion, that the Value of converting and ſmoothing the Outſide of a Block, with boring the Hole, may bear the following Proportion to the whole Charge of making the Block.

In ſingle Blocks cutting the Shiver Hole to the reſt of the Work as 3 to 1
In Double Blocks the Shiver-hole's to the reſt as — — — 6 to 1
In Treble Blocks ditto as — — — — — 9 to 1

Then there is to abate from making ſuch equal Allowances as is uſual in Single, Double, and Treble Blocks; that is to ſay, if a ſingle Block be valued at 6 *d.* the Double of the ſame Length will be 1 *s.* and Treble 1 *s.* 6 *d.* there is I ſay to be abated $\frac{1}{6}$ of the Charge in making a Double Block, and $\frac{1}{9}$ in making a Treble Block, beſides the Difference of the Timber.

Then I ſhall ſuppoſe here is a Single, Double and Treble Block to be made of 13 Inches long, and the Single to be valued at 13 *d*, the Double at 2 *s.* 2 *d.* and the Treble at 3 *s.* 3 *d.* according to the cuſtomary Method of equal Allowances.

I ſhall allow for Brevity ſake, that the Single Block takes up half a Foot of Timber at 12 *d. per* Foot, then there is 7 *d.* allowed for the Workman's Labour.

The Timber being 6 *d.* in a Single Block, 9 *d.* in a Double, and 12 *d.* in a Treble, ſo that the Workmanſhip in a Double Block it's 1 *s.* 5 *d.* and in the Treble 2 *s.* 3 *d.* However, I ſhall allow the Value of the Double Block 14 *d.* and the Treble 21 *d.* beſides the Fraction to be reduced; that is, $\frac{1}{6}$ of 14 taken from it, which is 2 *d.* $\frac{1}{4}$ for Brevity, Remains 11 *d.* $\frac{3}{4}$. and out of 21 *d.* $\frac{1}{9}$ of that Sum there remains 18 *d.* $\frac{3}{4}$.

Thus then; For making the Single Block	7 *d.*	Total 1 *s.* 1 *d.*
For Timber — — —	6 *d.*	
	13 *d.*	
For making the Double Block —	11 *d* $\frac{3}{4}$	Total 1 *s.* 8 *d.* $\frac{3}{4}$.
For Timber — — —	9 *d.*	
	20 *d.* $\frac{3}{4}$	
For making the Treble Block —	19 *d.* $\frac{3}{4}$	Total 2 *s.* 7 *d.* $\frac{3}{4}$.
For Timber — —	12 *d.*	
	2 *s.* 7 *d.* $\frac{3}{4}$.	

The Proportion of Value between a Single Block and a Double one of equal Length, will be as 5 to 8.

The Proportion between a Single Block and a Treble one of equal Length, will be as 3 to 7.

And this will prove an exact Rule for the Value of all Blocks, either Single, Double or Treble, provided they are of equal Size in Length, the other Dimenſions will follow.

I proceed now to ſhew how Blocks are proportion'd from their different Length, and the Value of Timber and Workmanſhip from that.

Firſt, I ſet down the Dimenſions of a ſmall Block of 5 Inches Length, and then draw a Proportion between their ſeveral Dimenſions.

	Inch.
Length of the Block	5
Breadth	4
Shiver-hole	0 ¾
Cheeks or Waſte	0 ⅞
Diameter Shiver	3
Ditto Thickneſs	0 ⅝
Pin's Diameter	0 ¾
Length of the Pin, or the Block's Thickneſs	2 ½

Proportion of the

Length to Breadth as	5	to	4
Length to Thickneſs as	2	to	1
Breadth to the Diam. of the Shiver	4	to	3
Diam. of the Shiver to the Thickneſs	4	to	1
Shiver-hole's Thickneſs to the Waſte or Cheeks	6	to	7
Shiver-hole to the Shiver as	6	to	5
Pin's Diameter to the Length or Thickneſs of the Block	3	to	10

	Inches.
A Block of 13 Inches Length contains, according to the preceeding Dimenſions	715
One of 8 Inches long contains	196
One of 5 Inches long contains	50

The Content in Inches of the 13 Inch Block to the 8 Inch Block is as 11 to 3, and the Content accordingly of the 13 to the 5 is near as 14 to 1.

The Value of ſmall Timber to great is as the Cube Roots of their ſeveral Contents are one to another; but the Converſion in the ſmall Blocks will be more valuable than in the great Blocks, by reaſon of the many Converſions, which I ſhall ſet oppoſite to the Extra Value of the Timber more in the large Timber than in the ſmall.

I ſhall allow that every 1728 Inches of ſuch Timber as theſe Blocks are made of will be worth 1 *s.*

If 1728 Inches is valued at 48 Farthings, what ſhall 715 Inches be: Anſwer, 19 Farthings $\frac{6}{10}$, or near 5 *d.* and 196 Inches is valued at 5 Farthings $\frac{4}{10}$, and 50 Inches 1 Farthing $\frac{38}{100}$.

But the cuſtomary Price is thus:		*s.*	*d.*
	13 Inch Block	1	1
	8 Inch Block	0	9 ½
	5 Inch Block	0	8

Then there is allowed for making the ſaid Blocks as follows:				
	13 Inch Block	0	8	
	8 Inch Block	0	8	$\frac{6}{10}$ of a Farthing.
	5 Inch Black	0	7	2 Farthings and $\frac{62}{100}$.

So that the Allowance for making is very near equal, but the Work cannot poſſibly be as much in ſmall Blocks as in large, ſince the Number of Holes in cutting the Shiver will be equal, but the Length will bear the Proportion as follows:

The 13 Inch to 8 Inch is as 11 to 7, ſo that here is ⅓ as much work more.

The 13 Inch to 5 Inch is as 11 to 4, and in this ⅔ more.

	Inches.
The Superficies in the 13 Inch Block is	286
In the 8 Inch Block	112
In the 5 Inch Block	40

The Proportion of 286 to 112 is as 18 to 7, and 286 to 40 is as 36 to 5.

Then here is a Compound Fraction of the Depth of the Shiver-hole, and the Superficies to find the Value of making the Blocks, thus:

$\frac{7}{11}$ of $\frac{7}{18}$ is * 7 × 7 = 49 Numerator; 18 × 11 = 198 Denominator. $\frac{49}{198}$ Reduced is $\frac{1}{4}$.

$$\begin{array}{rr} 7 & 18 \\ 7 & 11 \\ \hline 49 & 18 \\ \text{Numerator} & 18 \\ \hline & 198\ \text{Denominator.} \end{array}$$

$\frac{4}{11}$ of $\frac{5}{36}$ is * 4 × 5 = 20 Numerator; 36 × 11 = 396 Denominator. $\frac{20}{396}$. Reduced is near $\frac{1}{20}$.

$$\begin{array}{rr} 4 & 36 \\ 5 & 11 \\ \hline 20\ \text{Numerator.} & 36 \\ & 36 \\ \hline & 396\ \text{Denominator.} \end{array}$$

And then the Value of making muſt ſtand thus,

The 13 Inch Block's Value is 8 *d.* $\frac{1}{4}$ of 8 *d.* is 2 *d.* $\frac{1}{20}$ of 8 *d.* is but 1 Farthing and a half, or ſomething more.

But it is very likely that the Block-maker, when he ſees this very ſmall Allowance for ſuch Blocks, he will be apt to ſay he loſes by the large Size, and therefore cannot comply with this Proportion; but then as I have often ſaid, it's very hard that one Man ſhould loſe his Property to give it to another Man, as in divers Caſes it may happen, that ſome Men may wholly deal in ſmall Blocks, and others in large ones, and therefore it will be very hard for the ſmall Block Merchant to pay 7 *d.* for the Value of one Penny, becauſe the large Block Merchant has the Value of one Shilling for the Value of 8 Pence. However, I ſhall conſider it further, and ſet down a general Proportion.

Hitherto I have conſider'd theſe Blocks at ſo much a Piece, but the Cuſtom is to ſell ſuch Materials at ſo much per Foot Running Meaſure; ſo that the 13 Inch Blocks will be above 14 *d.* the 8 Inch Blocks 6 *d.* $\frac{3}{10}$, and the 5 Inch Blocks 3 *d.* $\frac{7}{20}$.

The Solid Inches contain'd in 12 Inches Length is thus,

	Inches		*d.*
In a 13 Inch Block	660	at 12 *d.* per Foot is	4 $\frac{1}{2}$
In an 8 Inch Block	294		2
In a 5 Inch Block	120		0 3 $\frac{3}{10}$

	d.	*d.*
Then there is allowed for the Work of the 13 Inch Block	9 $\frac{1}{2}$	
For the Work of the 8 Inch Block ——— ———		7 $\frac{1}{2}$, or 5 per Piece.
For the Work of the 5 Inch Block ——— ———		7 $\frac{7}{10}$, or 3 $\frac{2}{10}$ each.

Which is an over Value for making the ſmall Blocks, and therefore I ſhall allow, that as the Square of the Length in every ſingle Block is one to another, ſo ſhall the Price of making be. The Square of 13 is 169, the Square of 8 is 64, the Square of 5 is 25.

Thus, 169 *d.* *d.*
——— 64 Then as 169 is to 64, ſo is 9 $\frac{1}{2}$ to 3 $\frac{6}{10}$;
——— 25 And as 169 is to 25, ſo is 9 $\frac{1}{2}$ to 1 $\frac{4}{10}$.

Which putting the Charge of the Timber to it, gives the juſt Value of the Block, and may be a general Proportion for tht Value of ſuch Blocks.

The

	Inches.		*d.*	*q.*			*d.*
The Value of the Block	13	Its Timber is	4	3	$\frac{6}{10}$	Workmanship is	8
	8		1	1	$\frac{4}{10}$		3 $\frac{6}{10}$
	5		0	1	$\frac{38}{100}$		1

	Inch.		*d.*	*q.*			*d.*	
Which two Sums put together	13	——	12	3	$\frac{6}{10}$	Instead of	13	per Foot running Measure.
	8	——	4	1	$\frac{6}{10}$		9 $\frac{1}{2}$	
	5	——	1	1	$\frac{38}{100}$		8	

I proceed now to look a little farther into the Proportions of ſome other Blocks.

A Double Block ſtrap'd.

	Inches.
Length of the ſame	20
Breadth	18
Diameter of the Shiver	15
Shiver Hole thick or wide	3
Waſte or Cheek	3
Intervals	1 $\frac{7}{8}$
Shiver's Thickneſs	2 $\frac{7}{8}$

Proportion is

Length to Breadth	10	to	9
Length to Thickneſs	16	to	11
Breadth of the Block to the Diameter of the Shiver	6	to	5
Diameter of the Shiver to the Thickneſs	31	to	4
Shiver Hole's Thickneſs to the Cheeks or Waſte	1	to	1
Intervals to the Shiver Holes	23	to	24

A Double Block without a Strap,

	Inches.
Length	19
Breadth	12
Shiver Hole	2
Intervals	1
Cheeks or Waſte	3
Pins Diameter	2 $\frac{5}{8}$
Shiver's Diameter	8 $\frac{1}{2}$

Proportion is

Length to Breadth	11	to	7
Length to Thickneſs	12	to	7
Breadth of the Block to the Diameter of the Shiver	7	to	5
Shiver Hole's Thickneſs to the Waſte or Cheek	2	to	1
Pin's Diameter to the Length or Thickneſs of the Block as	4	to	27
Intervals to the Shiver Hole as	1	to	2

Another Single Block.

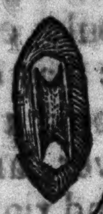
	Inches.
Length	10
Breadth	9
Shiver's Diameter	7 $\frac{1}{2}$
Thick	1 $\frac{1}{4}$
Shiver Hole	1 $\frac{1}{2}$
Cheeks	1 $\frac{1}{2}$
Pin's Diameter	1 $\frac{1}{4}$

Proportion is

Length to Breadth	10	to	9
Length to Thickneſs	9	to	4
Breadth of the Block to the Diameter of the Shiver as	6	to	5
Diameter of the Shiver to the Thickneſs as	28	to	5
Shiver Hole's Thickneſs to the Waſte or Cheeks as	1	to	1
Pin's Diameter to the Length, or Thickneſs of the Block	5	to	18

From ſuch Obſervations I ſhall endeavour to make a general Proportion for the ſizing of Blocks, only minding, that ſuch Blocks as are not ſtrap'd or bound with Wood or Iron have an Additional Subſtance allowed for ſtrengthning them without; but ſuch Blocks are not uſed in Rigging, becauſe of holding Wind, and hindering the Motion of the Ship.

And ſince a Block is no other in divers Caſes than a Conveniency for hauling a Rope different Ways, I ſhall conſider the Size from the Bigneſs of the Rope, only minding that ſuch Conveniencies ought to be nicely perform'd, as I have obſerv'd on the contrary, that the Wood provided to make ſuch Materials has been green, and ſo the Shiver Hole, with the Shiver, has bevel'd, which ſhould be as direct as it poſſibly could be made, for the more true Work and traverſing of the Shiver in the Shiver Hole, with as little vacant room on each ſide the Shiver as poſſible.



A

As in Figure A. Let the Inſide Parallelogram be the Shiver, on the Extreams of which let be a ſmall Margent or Ridge, as the Line. Let the Allowance for Play be the Outſide Parallelogram, and the Oblong Circle be the Bigneſs of the Block: I ſhall allow the Gully or hollow Part of the Shiver to be equal to the Diameter of the Rope, and the Square on each ſide the Shiver to be $\frac{1}{10}$ of the Thickneſs of the Shiver, the Play on each ſide $\frac{1}{16}$ of an Inch in all Shivers, which will ſuffice, provided the Work is well perform'd, and the Material fitting for the Deſign.

Let the Rope be 1 Inch Diameter
The Shiver muſt be 1 Inch and $\frac{1}{10}$. Thick.
The Shiver Hole muſt be 1 Inch $\frac{18}{100}$.

Length	8 Inches
Breadth	7 Inches
Diameter of the Shiver	5 $\frac{1}{4}$ Inches
Cheeks or Waſte	1 $\frac{16}{100}$ each.
Whole Thickneſs which is the Length of the Pin.	3 $\frac{54}{100}$
Diameter of the Pin	$\frac{81}{100}$

And for a general Proportion I ſhall calculate as follows, only minding, that in double and treble Blocks that are ſtrap'd, there are Intervals which are between the Shiver Holes, which may be half the Holes, otherwiſe the Shape and Proportion ſhall be the ſame in a ſingle Block as in a double.

A General Calculation for BLOCKS.

The Length of the Block to the Diameter of the Rope ſhall be as	8	to	1
The Length of the Block to the Breadth as	8	to	7
The Length to the Thickneſs in Single Blocks as	13	to	6
The Breadth of the Block to the Diameter of the Shiver as	19	to	13
The Diameter of the Shiver to the Thickneſs as	5	to	1
The Difference between the Thickneſs of the Shiver and the Shiver-hole for play, may be $\frac{1}{16}$ of an Inch in all ſorts of Blocks.			
The Cheeks or Waſte on each ſide the Shiver-hole to the Shiver-hole as	1	to	1
The Length of the Pin to the Diameter of the ſame as	9	to	2

And this will be a general Proportion for all ſorts of Blocks that are uſed on any Ship's Rigging; and as for other Blocks, whereof the Bigneſs hinders nothing, they may be made much ſtronger, as I have before mention'd.

Such Blocks as I have inſtanc'd, are in the ſtricteſt Senſe one of the 5 Mechanick Powers, perform'd with ſmall Rundles or Wheels, and are extreamly uſeful on Board of Ships, to traverſe the Rigging and ſet it to the Wind.

The Timber that makes the ſame ought to be extraordinary well ſeaſon'd, that it may not Shrink or Twiſt; for which Reaſon it ought all to be ſerved as I have hinted concerning the Seaſoning of Timber in another Part of this Treatiſe, and therefore ſhall ſay nothing of it here, only of the Advantage which will accrue thereby.

It will cauſe the Power to be Steady, and multiply, increaſing the ſame by it's moving gradually; for as I have obſerved, the Blocks which are made of Green Timber, after ſome time lying in the Magazines, provided for that purpoſe, have been ſo much out of Order when they came to be uſed, that, being forced to be unskilfully alter'd, and the Shiver-hole being ſtretch'd, and made ſo much too big for the Shiver, they have not only endanger'd the breaking of the Block, but by often wearing, the Rope has either got in between the Shiver and the Block, and ſo abſolutely ſtop'd the Purchaſe; or otherwiſe the Rope has Rid upon the Ridge of the Shiver, and cut that to Pieces, to the utter ſpoiling of the Rope, before in a juſt and right Uſe of the ſame it would have been half worn.

I now proceed to the Dead Eyes.

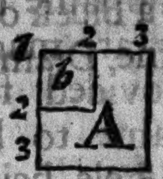
The Dead Eyes may almoſt as properly be call'd Blocks as the others; but having not Shivers or Rundles, they cannot be called Pulleys, tho' they are for the very ſame Purpoſe as all the Pulleys are, that is, to Reeve Ropes into; but having no increaſe of Wheels, it's no other than a Dead Inſtrument, ſince every Particle of the Wood is oppoſed to the Motion of the Rope, and adds to the Weight: And here would a very delightſome Scheme preſent itſelf, to conſider the Nature of increaſing Motion by Wheel-work, and the Difference between moving Pulleys and Dead Eyes or Blocks; but that being not to our preſent Subject, ſince it will more naturally come in amongſt the Engine Work proper for Building and Equipping ſuch Mchines, I ſhall only mention at preſent the moſt proper Shape of ſuch Inſtruments, and the Price.

A perfect Globular Shape would be the moſt proper for theſe Dead Eyes, ſince it would be the eaſieſt for the Strain of the Rope, and cauſe the Rope to wear longer, than if they were made of any other Figure; beſides, it would really pay the Charge, if there were ſmall Rundles put in at the Reeving of every Rope, it would certainly prevent the fretting of the Rope, and add to the Purchaſe, which would alſo cauſe the Rope to laſt much longer. But now to the Price, by the Cuſtom in two or three Inſtances.

	Inches Diam.	*For Stays:* s.	d.		*For Shrouds.* s.	d.
Dead Eyes of	30	3	0		0	0
	15	1	6	each		
	14				1	4
	8					
	7				0	9

In theſe Inſtances you may obſerve, that the Dead Eyes of half the Diameter of another are half the Value, as one of 30 Inches being 3 *s.* the other of 15 is 1 *s.* 6 *d.* nay one of 14 Inches is ſo too; and again, one of 14 Inches being 1 *s.* 4 *d.* the other of 7 is but 9 *d.*

And here I cannot forbear merrily to deſcant upon the Paſſage of Two Farmers; of whom one had Occaſion to borrow Hay of the other, and comes to him: Says he, Neighbour, can you lend me a parcel of Hay; yes, ſays t'other, I have a Stack of 20 Foot Square, which I'll ſpare you. The Borrower, when an Opportunity preſents, comes to his Friend, and offers to pay him in Stacks of 10 Foot Square, and his Friend readily accepts of Two 10 Foot Stacks for one of 20 Foot; but when it came to the View, whether it paſs'd for full Payment I cannot ſay; however, this far I know, that the Two 10 Foot Stacks was but $\frac{1}{4}$ Part of the 20 Foot Stack, and after ſuch a manner I ſhall conſider the ſaid Dead Eyes; for whether you conſider them as Squares or Globes, or any other Oblong Forms, that are Similar one to another, the Content is the ſame, as for Inſtance:



Let the Figure A. be a perfect Cube or Die Square, and let *b.* alſo be imagined to be a Cube or Die Square taken out of the large one A. Let 1, 2. be exactly one half of 1, 2, 3. then *b.* will contain but $\frac{1}{8}$ Part of A. but if you conſider them as Superficies, then *b* will contain $\frac{1}{4}$ Part of A. and ſo on; and what is here ſaid of Squares, will be applicable to Globular Figures, whoſe Diameters are one to another as the Sides of the Cubes or Die Squares.

Therefore the Timber contain'd in a Dead Eye of 15 Inches Diameter, contains but $\frac{1}{8}$ Part of the Dead Eye which is 30 Inches Diameter, and to be valued no otherwiſe as to the Timber; but ſince the Superficies are to one another as 4 to 1, alſo the ſcore of the Plate is as 4 to 1, the Number of Holes being equal, tho' but half the Length with different ſized Augres; however, I ſhall allow the Holes to be as 4 to 1, until I have conſidered the different Reſiſtance there will happen in Augres, according to the different Size.

I proceed and ſhall draw a Parallel between a Dead Eye of 12 Inches Diameter, and one of 6 Inches Diameter; however, I ſhall conſider them as Squares, ſince the Waſte will be no other than Chips.

I will allow a good round Price for the Timber, becauſe it ought to be that which is very ſound and good, and ought to be well ſeaſoned, and 10 *d. per* Foot I allow for both, and the often Converſion, in ſmall Timber, as I ſaid before, I ſhall put to ballance againſt the Largeneſs of the Timber requiſite in one more than in another; tho' I will not be abſolute to ſay, that ſuch Timber may be ſized after ſuch a manner, that the Converſion may chance to be leſs in the ſmall Timber than in the large; however, I allow the Timber to be 10 *d.* in a 12 Inch Dead Eye, perfect Globular, and the Workmanſhip to be 8 *d.* for you may obſerve, as I ſaid before, that a Dead Eye of 12 Inches Diameter, made perfect Globular, will be better for the Uſe than one of 15 Inches made according to the preſent Faſhion.

I ſhall divide the working Part into four Parts, allowing for ſhaping and ſmoothing the Dead Eye two Parts, and the Holes one Part, and cutting the ſcore for the Plate another Part.

		s.	*d.*		*s.*	*d.*
It ſtands thus.	Timber	0	10	The $\frac{1}{8}$ Part is	0	1 $\frac{1}{4}$
	Smoothing and Trimming	0	4	The $\frac{1}{4}$ Part is	0	1
	Cutting the Score	0	2	The $\frac{1}{4}$ Part is	0	0 $\frac{1}{2}$
	Boring the Holes	0	2	The $\frac{1}{4}$ Part is	0	0 $\frac{1}{2}$
	Total	1	6	Total	0	3 $\frac{1}{4}$

So that inſtead of the common Allowance for a Dead Eye of 6 Inches Diameter, which is 8 *d.* they are really valuable but at 3 *d.* $\frac{1}{4}$ a piece.

But now perhaps the Block-maker may cry out, I am ruined if I come to theſe Prices, I can never hold my Contracts; however, a little Patience will demonſtrate the Caſe, and ſhew him that theſe are really the true and genuine Calculations, and that he need be no Loſer; for if he looks upwards, he will find that a Dead Eye of 2 Foot Diameter will come to 9 *s.* 6 *d.* and the common Price but 2 *s.* 6 *d.* and therefore I only argue as I have done in other

Places, that it will be very hard for Owners of ſmall Shipping to pay for the Materials that Rigs large Shipping.

Then for a general Proportion; ſay firſt, as the Cubes of the Diameters are one to another, ſo is the Price of the Timber one to another; and as the Squares of the Diameters are one to another, ſo is the Price of the Workmanſhip one to another.

Example.

24 } 576. Then as 576 is to 144, ſo is 2 *s.* 8 *d.* the making a Block of
Square of 12 } is 144. 2 Ft. Diam. to 8 *d.* the making one of 12 Inc. Diam.
6 } 36. And as 144 is to 36, ſo is 8 *d.* to 2 *d.*

24 } 13816 Then as 13816 is to 1728, ſo is 6 *s.* 8 *d.* to 10 *d.*
Cube of 12 } is 1728.
6 } 216. And as 1728 is to 216, ſo is 10 *d* to 1 *d.* $\frac{1}{4}$.

And theſe Obſervations will hold, provided this ſort of Materials are ſhaped Similar, and according to Cubick Figures.

I now proceed to the Parrels.

The Parrels are Parts compoſed with Ribs and ſmall Truts, for artificially claſping the Maſt, and binding the Yard to the ſame; and here we ſhould in ſome meaſure be guided by the Experimental Stay-maker for Womens Bodies, that our Sizes may be nice and genuine in ſuch Materials; but forbearing that at preſent, I ſhall only examine into the Price, which will be as follows.

	s.	*d.*		*s.*	*d.*
For the Main-Maſt of a firſt Rate	18	0	Second Rate.	16	0
For the Top Maſt of ditto ——	8	0		6	0
For the Top-gallant Maſt ——	3	6		3	0

	s.	*d.*		*s.*		*s.*	*d.*		*s.*	*d.*
Third Rate.	14	0	Fourth Rate.	11	Fifth Rate.	8	0	Sixth Rate.	6	0
	5	0		5		4	6		3	6
	2	8		2		2	0		1	6

Proportion of the Yards		First Rate *In. Diam.*	Second Rate. *In. Diam.*
	Main Yard.	24	22 $\frac{1}{2}$
	Top ſail Yard.	13 $\frac{2}{3}$	12 $\frac{2}{3}$
	Top-gallant Yard.	7	6 $\frac{3}{4}$

	In. Diam.		*In. Diam.*		*In. Diam.*		*In. Diam.*
Third Rate.	20 $\frac{3}{4}$	Fourth Rate.	18 $\frac{2}{3}$	Fifth Rate	15	Sixth Rate.	12 $\frac{3}{4}$
	11 $\frac{2}{3}$		10 $\frac{1}{4}$		8 $\frac{1}{4}$		7 $\frac{1}{4}$
	6 $\frac{1}{4}$		5 $\frac{1}{2}$		4 $\frac{1}{4}$		3 $\frac{8}{10}$

Firſt Rates Main-Yard to the ſecond Rate is as —— —— 16 to 15
The Money is as 18 to 16, which ſhould be as —— 18 to 16 $\frac{9}{10}$
Firſt to thirds Main-Yard is as —— —— —— 15 to 13
The Money is as 18 to 14, which ſhould be as —— —— 18 to 15 $\frac{6}{10}$
Firſt to fourths Main-Yard is as —— —— 9 to 7
The Money is as 18 to 11, which ſhould be as —— 18 to 14

Firſt to fifth Main-Yard is as ——— ——— 8 to 5
The Money is as 18 to 8, which ſhould be as —— —— 18 to $11\frac{2}{10}$
Firſt to ſixth Main-Yard is as ——— ——— —— 24 to $12\frac{3}{4}$
The Money is as 18 to 6, which ought to be as ——— 18 to $9\frac{1}{2}$

And this will be a nice Point well conſider'd, for in this Calculation I muſt needs pleaſe the Block-maker, not but that he may make his Parrels agreeable to theſe Rules and Prices I have inſtanc'd: However, I am to enquire, whether the Neceſſity of the Material will require to be ſo ſized.

Then I am to enquire, which way this Calculation is to be adjuſted, in the Proſecution of which I ſhall draw one Parallel between the Main-Yard of a firſt Rate and the Main-Yard of a ſixth Rate; the Diameter of the firſt being 24 Inches, and the ſecond's Diameter being $12\frac{3}{4}$, their Lengths are alſo agreeable to their Diameter; ſo that the Content is near as 3 to 1, and ſo is the Weight; but however, the Weight of the Yards being but inconſiderable to the Area of the Sail, and from thence the Impulſe cauſed by the Wind, therefore I ſhall be guided by the Area of the Sail for to Size the Parrels; which Area's of the Sail between the firſt and ſixth Rate are near as 4 to 1, and ſo is the Area of the Circle at the Slings, or biggeſt Part of the Yard, and from thence I ſhall Size the Parrels.

Area's of a			Price of the Parrels agreeable to the Area of the Sails.	s.	d.
	Firſt Rate's Yard at the Slings is	453		18	
	Second ——	397		$15\frac{7}{10}$	
	Third ——	339		13	6
	Fourth —— ——	270		$10\frac{7}{10}$	
	Fifth —— ——	176		7	
	Sixth —— ——	126		5	

The cuſtomary Price for this Material comes as near or nearer to a regular and agreeable Rule than any Material that I have con'd over yet.

I proceed now to the Turn'd Pillars, which is ſomething of Turnery-work, altho' in the Block-maker's Contract.

Turning is perform'd by Wheel, tho' in ſmall Work there is no other force applied than a Lathe or Spring above the Work, and under it the Foot of a Man moving a Treddle; the Part to be turned is moved either with ſuch a Device or a Wheel, having a String winded about, and faſten'd either to the Lathe and Treddle, or put about the Wheel. This Mechanick Invention is not hard Work, but very delightſome; for the Workman only ſtands to his Work, applying the Tool from his Breaſt againſt the Timber.

However, here are pretty Conſiderations concerning this Performance, and he that looks narrowly into it, will find it may be vaſtly improved by applying a Wheel inſtead of the Lathe and Treddle, ſince the Wheel has a continual Motion, and cauſes the Tool to be always cutting, whereas the Lathe and Treddle loſes half by the Spring or Elaſticity; ſo that a very little Boy, nay a Man's own Foot (with Wheel-work well applied) would ſave half the Time of a very able Turner. But to proceed,

I ſhall only mention one Inſtance which is in Turn'd Pillars for ſupporting Decks.

Price of one of	Foot long.	s.	d.	each.	Inches Diameter.
	7	2	2		7
	6	1	6		6
	5	1	0		5
	4	0	6		4
	3	0	3		3

I ſhall allow the Diameter of the Pillar in the Medium to be 1 Inch to every Foot in Length, tho' it doth not happen ſo in all caſes; however, the Proportion may ſuffice, and be very rational, provided the Heighths of the Deck are adapted to the Magnitude of the Ship.

Now if the Pedeſtal or the Waſte left unturn'd be agreeable to the Length and Diameter, the Proportion of the Price will be agreeable to the Area of the Pillar, which is as follows.

						s.	d.
	7	Foot	164			2	2
	6	Length	112 $\frac{1}{4}$	The Superficial	Price one	1	7 $\frac{1}{4}$
The	5	and Diam.	79	Area of the whole	to another.	1	0 $\frac{1}{2}$
	4	Inches alſo.	50 $\frac{4}{10}$	Pillar.		0	8
	3		28 $\frac{5}{10}$			0	4 $\frac{1}{2}$

Theſe are fair Calculations, provided every Size is made out of one ſort of Timber; but if they are not, the Property will be alter'd, as I have mention'd elſewhere, according to the Hardneſs and Rudeneſs of the Material brought to the Lathe, as they call it.

In the next Place I come to conſider of the Pumps, of which for Shipping there be two ſorts, Chain-Pumps and Hand-Pumps, the former of which is an admirable Engine for the Uſe that it's applied to. A better, in my Opinion cannot be; Notwithſtanding as I have hinted in another Place, an Amendment may be made of the Uſe, but that is not to our preſent Deſign, only to bring ſuch Materials to general Prices.

			l.	s.	d.	
	Firſt Rates	———	3	7	6	
The Cuſtomary Prices are for	Second Rates	———	3	7	6	For Chain-Pumps.
	Third Rates	———	3	0	0	
	Fourth Rates	———	3	0	0	
	Fifth Rates	———	2	5	0	

Which Pumps ought in ſome Meaſure to be valued according to the Length, for the Breadth may be agreeable to that, and thoſe Dimenſions ought to be produced from the Depth in the Hold; which may directly guide us to the Value of the Timber: But then as to the Workmanſhip there are two Conſiderations; firſt to the Shaping of the Tree to the Faſhion of the Pump, and in the next Place, to the boreing of the Hole, and here I ſhall inſtance my Opinion of the different Charge in boring of Holes with different ſized Augres.

As for Example, Let me draw one Parallel between an Inch Augre and a two Inch Augre; the Diameter of the Augre is but as 2 to 1, and ſo it may be expected the Value of Boring the whole may be, but however the Content of the Bore is as 4 to 1, and ſo it is very probable the Value of Boring the Hole may be, ſince, as I have ſaid before of Saws, the Augre muſt be made bigger and heavier, according to the Bigneſs of the Hole; the Strength requiſite will be alſo more in large Augres than thoſe that are leſs, as well to equal the Weight of the Augre, as the Weight of the Core that comes out of the Hole; ſo that I ſhall allow this Difference in boreing of Holes to be agreeable to a Square made by the Diameter of the Augre; and ſince I ſhall deduce it from an half Inch Augre, I ſhall break the Inches into half Inches as follows.

Diameter of the Augre	Half Inches which is	Inches	The Diameter of the Augre ſquar'd, which is equal to the Reſiſtance, and from thence the Value of boring ſuch Holes.
1	0		1
2	1		4
3	$1\frac{1}{2}$		9
4	2		16
5	$2\frac{1}{2}$		25
6	3		36
7	$3\frac{1}{2}$		49
8	4		64

The Depths in the Hold are as follows,	
The Firſt Rate	19
The Second Rate	18
The Third Rate	16
The Fourth Rate	14
The Fifth Rate	12

The Bigneſs ought to be made agreeable to the Length, and the Bigneſs of the Bore ought to be made proportionable to the Cavity of the Hold, that the Artifice of forcing Water out of a Ship may be ſimilar to the Water that may be held by the Cavity that receives it, and this ought really to be, whether your Conveniency be made up with one Pump or ſeveral.

I ſhall allow that the longeſt Pump's Bigneſs ſhall be 15 Inches, and the Hole to be 5 Inches or $\frac{1}{3}$, and that the Square of the Diameter ſhall be agreeable to the Depth in the Hold, which for Brevity-ſake, ſhall ſhadow out the Cubick Feet of Water contain'd in the Cavity.

Depth in Hold.	Square of the Diam.	Diam. of the Bore.	Bigneſs of the Pump is
19	25	5	15
18	$23\frac{3}{4}$	$4\frac{87}{100}$	$14\frac{6}{10}$
16	21	$4\frac{6}{10}$	$13\frac{8}{10}$
14	$18\frac{1}{2}$	$4\frac{3}{10}$	$12\frac{8}{10}$
12	$15\frac{8}{10}$	$3\frac{97}{100}$	$11\frac{9}{10}$

The Content of each Pump to the Gun-deck is, in Cubick Feet.	The Superficial Area is as a Square Pump, which I ſhall at preſent allow.
$29\frac{1}{2}$	95
$26\frac{1}{2}$	88
$21\frac{2}{10}$	74
$15\frac{9}{10}$	60
$11\frac{8}{10}$	$47\frac{1}{2}$

And now to the Value, where I have three Particulars to adjuſt the ſame, as the Price and Value of the Timber, the Value of boring the Hole, and ſhaping the Pump, and putting in the Rowel.

The Price of the Timber in the largeſt Pump I ſhall allow to be 3 *l.* 10 *s.* per Load, or 50 Foot; and ſince I allowed the Content as Dye Square Timber, it ſhall ſuffice for the Length that will be required Upwards and Downwards, beſides the Depth in the Hold; and for the Price of the other I ſhall produce it from the Cube of the Content; and although this is ſeemingly a great Price for Elm Timber, yet we muſt conſider that it ought to be the beſt Sort, clear of any manner of Defect, eſpecially in Hand-Pumps, where the leaſt Hole will hinder the working or Uſe of the Pump.

The Contents are	Cube of the Content	Price per Load is *l.*	*s*	*d.*
$29\frac{1}{2}$	$3\frac{1}{10}$	3	10	0
$26\frac{1}{2}$	$2\frac{19}{20}$	3	6	6
$21\frac{2}{10}$	$2\frac{15}{20}$	3	2	0
$15\frac{9}{10}$	$2\frac{5}{10}$	2	16	6
$11\frac{8}{10}$	$2\frac{3}{10}$	2	7	0

Then

	l.	s.	d.
Then the Paice of the Content is	2	1	0
	1	15	0
	1	6	2
	0	18	0
	0	11	2

The Price of the Timber, which ſubſtracted out of the whole Money, ſerves for the Work.

The Money allowed for the Work is		l.	s.	d.
	The Firſt Rate	1	6	6
	The Second Rate	1	12	6
	The Third Rate	1	13	10
	The Fourth Rate	2	02	0
	The Fifth Rate	1	13	10

This ſeems ſomewhat like putting the Cart before the Horſe, more allowed for making a ſixth Rate's Pump than a firſt Rate's, or otherwiſe that our former Calculators were no great Mechanicks, nor had conſider'd much of Ingineer-Work; however that the Merchant may ſee that I deſign him Juſtice, I will allow that the middle Pump, or third Rate's, ſhall be worth 1*l.* 13 *s.* 10 *d.* and Value the other from him, though I am apt to believe than an Engine well applied with a Horſe, and one Man to tend him, would bore a great many ſuch Pumps in one Day, and that two mean Men might ſhape them in one Day; however allowing the ſhaping to be ¼ Part of the Boreing, I begin and calculate it as follows.

	l.	s.	d
For boreing the Third Rate's Pump	1	7	1
For ſhaping	0	6	9

The Square of the Diameter of the Bore	
Firſt	25
Second	23 $\frac{3}{4}$
Third	21
Fourth	18 $\frac{1}{2}$
Fifth	15 $\frac{8}{10}$

	l.	s.	d.
Then the Price of Boring will be	1	13	9
	1	11	6
	1	7	1
	1	5	0
	1	1	3

The Superficial Area in Feet is
95
88
74
60
47½

	s.	d.
Then the Value of ſhapeing, &c. is	8	8
	8	0
	6	9
	5	6
	4	4

	l.	s.	d.
Then adding the Value of the Timber, Boreing, and Shaping all together it is	4	3	5
	3	14	6
	3	00	0
	2	16	6
	1	16	9
	15	11	2

	l.	s.	d.
As Cuſtom is	3	7	6
	3	7	6
	3	0	0
	3	0	0
	2	5	0
	15	0	0

By theſe Calculations the Block-maker, or indeed Pump-maker, may perceive that I deſign not to undervalue his Work, only to bring it to Generals, and not allow equal Prices for Things that are ſo very different both in making and the Timber. Neither would I have a Merchant ſay, when he declares his Mind to ſome particular Perſons, and they tell him that he gains very conſiderable by ſuch and ſuch Materials, he preſently replies, that he loſes as much by others; however they may chuſe whether they believe him or not, unleſs he ſhews his Contract throughout, and ſo the Owner, or they that are employ'd to bargain with the Merchant is cenſured either for being deficient in not knowing how to calculate the Charge or Value, or otherwiſe Knaviſh in giving away their Maſter's Money Voluntarily.

I ſhould not have purſued this Contract any further, only in inſtancing my Opinion of the Difference between the Chain-Pumps and the Hand-Pumps; but obſerving ſomething of Novelty in the Prices per Foot given for Hand-Pumps, I proceed to them.

			s.	d.	
The Cuſtomary Price for Hand-Pumps is	From 8 to 14	Feet long.	1	3	per Foot.
	From 15 to 18		1	6	
	From 19 to 26		2	0	
	From 27 to 30		2	6	

But this ſeems to be a lazy Calculation, that from 8 Foot long to 14 Foot ſhould be all of one Price, and ſo on; however, I ſhall conſider it in the Medium.

I have obſerved a Pump of 26 Foot long to be 10 Inches Diameter in the Middle, which allowing it to be the Square of the Piece at the Meaſure Place, the Content will then be 18 Feet. I ſhall allow the Diameter of the Bore to be $\frac{2}{5}$ of the Diameter of the Pump.

$\frac{2}{5}$ of 10 is 4 Inches, the Square of 4 is 16, ſo if 26 produce 16, what ſhal the other Lengths produce.

Feet long.	Square of the Diameter.	The Diameter of the Bore; however I ſhall not confine the Workman to fit an Augre to every one of theſe Sizes, but as near as he can, with eaſing the Expence of the Augre. Inch.	Square of the Pump at the Meaſure Place. Inch.	Content of the Timber in Feet and Parts. Feet.	Cube Root of the Content.
8	$4\frac{9}{10}$	$2\frac{21}{100}$	$5\frac{1}{2}$	$1\frac{7}{10}$	$1\frac{18}{100}$
9	$5\frac{5}{10}$	$2\frac{32}{100}$	$5\frac{8}{10}$	$2\frac{1}{10}$	$1\frac{28}{100}$
10	$6\frac{1}{10}$	$2\frac{47}{100}$	$6\frac{2}{10}$	$2\frac{7}{10}$	$1\frac{4}{10}$
11	$6\frac{3}{4}$	$2\frac{6}{10}$	$6\frac{1}{2}$	$3\frac{2}{10}$	$1\frac{47}{100}$
12	$7\frac{4}{10}$	$2\frac{72}{100}$	$6\frac{8}{10}$	$3\frac{17}{20}$	$1\frac{57}{100}$
13	8	$2\frac{83}{100}$	7	$4\frac{4}{10}$	$1\frac{63}{100}$
14	$8\frac{6}{10}$	$2\frac{91}{100}$	$7\frac{3}{10}$	$5\frac{2}{10}$	$1\frac{74}{100}$
15	$9\frac{2}{10}$	$3\frac{2}{100}$	$7\frac{1}{2}$	$5\frac{17}{20}$	$1\frac{8}{10}$
16	$9\frac{8}{10}$	$3\frac{5}{40}$	$7\frac{8}{10}$	$6\frac{8}{10}$	$1\frac{9}{10}$
17	$10\frac{4}{10}$	$3\frac{9}{40}$	$8\frac{1}{20}$	$7\frac{8}{10}$	$1\frac{98}{100}$
18	11	$3\frac{3}{10}$	$8\frac{1}{4}$	$8\frac{1}{2}$	$2\frac{1}{20}$
19	$11\frac{6}{10}$	$3\frac{4}{10}$	$8\frac{1}{2}$	$9\frac{1}{2}$	$2\frac{1}{10}$
20	$12\frac{3}{10}$	$3\frac{5}{10}$	$8\frac{3}{4}$	$10\frac{6}{10}$	$2\frac{2}{10}$
21	$12\frac{9}{10}$	$3\frac{23}{40}$	$8\frac{9}{10}$	$11\frac{1}{2}$	$2\frac{1}{4}$
22	$13\frac{5}{10}$	$3\frac{27}{40}$	$9\frac{2}{10}$	$12\frac{8}{10}$	$2\frac{7}{20}$
23	$14\frac{1}{10}$	$3\frac{3}{4}$	$9\frac{4}{10}$	$14\frac{1}{10}$	$2\frac{17}{40}$
24	$14\frac{8}{10}$	$3\frac{17}{20}$	$9\frac{6}{10}$	$15\frac{4}{10}$	$2\frac{5}{10}$
25	$15\frac{4}{10}$	$3\frac{37}{40}$	$9\frac{3}{4}$	$16\frac{4}{10}$	$2\frac{11}{20}$
26	16	4	10	18	$2\frac{25}{40}$
27	$16\frac{6}{10}$	$4\frac{3}{40}$	$10\frac{2}{10}$	$19\frac{8}{10}$	$2\frac{7}{10}$
28	$17\frac{2}{10}$	$4\frac{3}{20}$	$10\frac{4}{10}$	$21\frac{1}{10}$	$2\frac{15}{20}$
29	$17\frac{8}{10}$	$4\frac{2}{10}$	$10\frac{1}{2}$	$22\frac{4}{10}$	$2\frac{8}{10}$
30	$18\frac{4}{10}$	$4\frac{11}{40}$	$10\frac{7}{10}$	$23\frac{1}{2}$	$2\frac{35}{40}$

l.	s.	d.	l.	s.	d.	*Feet Length.*	l.	s.	d.	l.	s.	d.
1	6	6	0	0	6 ¼	8						
1	8	6	0	1	2 ¼	9						
1	11	6	0	1	8 2/4	10						
1	13	0	0	2	1 ½	11	0	13	9	0	11	7 ½
1	15	3	0	2	8	12						
1	16	9	0	3	3	13						
1	18	10	0	4	0	14						
2	00	6	0	4	8 ½	15						
2	2	9	0	5	9 ¼	16	1	04	0	0	18	3 ¼
2	4	6	0	6	10	17						
2	6	0	0	7	10	18						
2	7	3	0	9	0	19						
2	9	8	0	10	4	20						
2	10	4	0	11	7	21						
2	13	0	0	13	6	22	2	04	0	1	10	6
2	15	0	0	15	6	23						
2	16	6	0	17	5	24						
2	17	6	0	18	11	25						
2	19	0	1	1	0	26						
3	1	0	1	4	0	27						
3	2	0	1	6	0	28						
3	3	0	1	8	0	29	3	12	6	1	04	6
3	4	0	1	10	0	30						

Price per Load, or 50 Foot.

Price of the Timber for each Pump.

The Money allowed as Custom for the whole Work and Material, out of which subſtracting the Value of the Timber, remains the Value of the Work.

And here you may obſerve the ſame Meaſure practis'd, which is to allow more for making a 22 Foot Pump than a 29 Foot Pump, which is undeniably Erroneous.

I ſhall therefore produce a Calculation for the Value of the Work from the 22 Foot Pump's Value, and from the Square of the Bore.

l.	s.	d.	l.	s.	d.	l.	s.	d.
0	0	6 ¼	0	4	2	0	0	10
0	0	7	0	5	3	0	1	0 ½
0	0	7 ¾	0	6	5 ½	0	1	3 ½
0	0	8 ½	0	7	9 ½	0	1	6 ½
0	0	9 ½	0	9	6	0	1	11
0	0	10 ¼	0	11	1 ¼	0	2	2 ½
0	0	11	0	12	10	0	2	6 ¼
0	0	11 ¾	0	14	8	0	2	11 ¼
0	1	0 ½	0	16	8	0	3	4
0	1	1 ¼	0	18	9 ¼	0	3	9
0	1	2	1	1	0	0	4	2 ½
0	1	2 ¾	1	3	2 ¼	0	4	7 ½
0	1	3 ½	1	5	10	0	5	2
0	1	4	1	8	0	0	5	7 ¼
0	1	4 ¼	1	10	8	0	6	1 ½
0	1	6	1	14	6	0	6	11
0	1	6 ¾	1	17	6	0	7	6
0	1	7 ½	2	0	7 ½	0	8	1 ½
0	1	8 ¼	2	3	10	0	8	9 ¼
0	1	9	2	6	9	0	9	3
0	1	10	2	11	4	0	10	3 ¼
0	1	10 ¾	2	15	0	0	11	0
0	1	11 ½	2	18	9	0	11	9

The Value of Boreing each Pump per Foot.

The whole Value of the Work, the ⅕ of which is the Value of Shapeing.

Diameter of the Main Yard.

7 to 22, ſo is	24	to	75 ½	Half the Circumference is	37 ¾	Half the Diameter is	12	Mult-ply'd is	453	For the Parrels.
	22 ½		70 ½		35 ¼		11 ¼		397	
	20 ¾		65		32 ½		10 ⅜		339	
	18 ⅔		58 ½		29 ¼		9 ⅓		290	
	15		47		23 ½		7 ½		176	
	12 ¾		40		30		6 ⅜		126	

7 to 22, ſo is	7	to	22	Circumference multiply'd by the Height	22	by	7	is	164	Area of the whole Pillar Superficies.
	6		18 8/10		18 8/10		6		112 1/10	
	5		15 8/10		15 8/10		5		79	
	4		12 6/10		12 6/10		4		50 4/10	
	3		9 5/10		9 5/10		3		28 5/10	

The Value of the Work and Timber put together is

From this the Price per Foot will be

Feet.	l.	s.	d.	l.	s.	d.
8	0	4	8 ¼	0	0	7
9	0	6	5 ¼	0	0	8 ½
10	0	8	1 ½	0	0	9 ¾
11	0	9	11	0	0	10 ¼
12	0	12	2	0	0	12
13	0	14	4 ¼	0	1	1 ¼
14	0	16	10	0	1	2 ½
15	0	19	4 ½	0	1	3
16	1	2	5 ¼	0	1	4 ½
17	1	5	7 ¼	0	1	6
18	1	8	10	0	1	7 ½
19	1	12	2 ¼	0	1	9
20	1	16	2	0	1	10 ½
21	1	19	7	0	1	11 ¾
22	2	4	2	0	2	0 ¼
23	2	10	0	0	2	1 ¾
24	2	14	11	0	2	2 ¼
25	2	19	6 ½	0	2	3 ¼
26	3	4	10	0	2	4 ¾
27	3	10	9	0	2	6 ½
28	3	17	4	0	2	8
29	4	3	0	0	2	9
30	4	8	9	0	2	11 ½

And theſe are Calculations that are agreeable to Rule, whether profitable or not, I am not poſitive; they are very delightſome, when I conſider the general Benefit that may flow from them.

I ſhall offer nothing elſe at preſent concerning the Block-maker's Contract, believing there is ſcarce any Thing elſe which is very Material, only the Round Tops, which to conſider Naturally with Nicety, would take up a ſmall Volume, ſo that I ſhall end this Branch at preſent with giving my Opinion of the Difference between Chain and Hand-Pumps.

The former, as I hinted before, is as good an Engine, well applied, as ever was or will be made uſe of for pumping or drawing Water out of a Ship; and there is no Man that rightly conſiders the Advantage of this Engine but would, (if it was poſſible to apply it) have it on Board the Ship he either owns or ſails in; for there is a vaſt Difference between it and the Hand-Pump, as I have ſaid elſwhere about Capſtands and Windlaſſes, one being Continual, and the other having its Viciſſitudes, or change of Motion.

The Chain-Pump is perfectly Increaſe of Wheel, and is conſtantly moved with Advantage; but the Hand-Pumps can be beſt reduceable to the force of a Leaver, which although of great Force and Power, while moving, notwithſtanding that Force will diſcontinue, and require Change of Place, according to the Convenience you have in placing your Leaver; ſo your Pump-Brake, although very efficacious in drawing the Water, while the Purchaſe continues, yet when that is over, it not only ceaſes to be Profitable, but on the contrary, by recovering a new Force or Power, it ſprings backward, ſo that there is above half the Difference between theſe Pumps forcing Water out of a Ship, and that moſt profitable Engine the Chain-Pump, according as they are uſed now.

OF THE

Sail-maker's CONTRACT.

ALL *Holland* Duck, great Noyals, *Suffolk*, and the like, to be ſowed with a double flat Seam. All ſmaller ſort of Canvas to be ſowed with a round Seam.

Double *Ipſwich*, or ſmall Noyls Courſes		108	Stitches in a Yard, and not under.
Top ſails, Sprit-ſails, and Mizens.	Duck	100	
	Noyls and *Suffolk*	90	
Vittroy, Pertrees, or ſmall Noyls wrought into any ſort of ſingle Sails, and ſowed with a ſingle round Seam.		90	

Bolt Rope to be Croſs-ſtitch'd at every 12 Inches in Length with three Croſs-Stitches, and the Rope to be of the Diameter as follows.

Sails.	First Rate *Inch.*	Second Rate *Inches.*	Third Rate *Inches.*	Fourth Rate *Inches.*	Fifth Rate *Inch.*	Sixth Rate *Inch.*
Main Courſes	6	$5\frac{1}{2}$	5	$4\frac{1}{2}$	4	$3\frac{1}{2}$
Fore Courſes	$5\frac{1}{2}$	5	$4\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{1}{2}$	3
Main, Fore Top-ſails	$5\frac{1}{2}$	5	$4\frac{1}{2}$	4	$3\frac{1}{4}$	$2\frac{3}{4}$
Mizen, Sprit-ſail Courſes	5	$4\frac{3}{4}$	4	$3\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{2}$
Main Stay-ſail.	$3\frac{1}{4}$	3	3	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{4}$

That all Sails which are made of Pertrees, Vittroy, and ſuch Canvas, ſhall have a round Seam in the middle of each Cloth; to be allowed for flat Seamed Sails 3 *d.* ¼ *per* Yard, and for round Seamed Sails 2 *d.* ¾ *per* Yard.

	Yards.	
The Sails are one to another as	3969	The Firſt Rate.
	3660	The Second Rate.
	3080	The Third Rate.
	2270	The Fourth Rate.
	1441	The Fifth Rate.
	1225	The Sixth Rate.
	15645	

Cloth

			s.	d.	
Cloth Canvas.	Duck		2	0	*per* Yard.
	Suffolk		1	6	
	German		1	6	
	Noyls	Great	1	4	
		Small	1	4	
	Vittroy		1	0	
	Ipſwich		1	1	
	Old		0	4	
	Tarpawlings		0	4	
Kerſey	New		1	4	*per* Yard.
	Old		0	1 ½	
Cotton Red	New		1	0	
	Old		0	1	

	Inch.	Circumference of the Rope.	Diameter.	
Bolt Ropes.	6	1 $\frac{92}{100}$	3 $\frac{7}{10}$	Area is 2 $\frac{88}{100}$.
	5 ½	1 $\frac{75}{100}$	3 $\frac{3}{40}$	
	5	1 $\frac{60}{100}$	2 $\frac{11}{20}$	Area is 2 0
	4 ¾	1 $\frac{52}{100}$	2 $\frac{3}{10}$	
	4 ½	1 $\frac{44}{100}$	2 $\frac{3}{40}$	Area is 1 $\frac{62}{100}$.
	3 ¾	1 $\frac{20}{100}$	1 $\frac{84}{100}$	
	3 ½	1 $\frac{12}{100}$	1 $\frac{26}{100}$	
	4	1 $\frac{28}{100}$	1 $\frac{64}{100}$	Area is 1 $\frac{28}{100}$.
	3 ¼	1 $\frac{4}{100}$	1 $\frac{96}{1000}$	
	3	0 $\frac{98}{100}$	0 $\frac{96}{100}$	Area is 0 $\frac{69}{100}$.
	2 ¾	0 $\frac{88}{100}$	0 $\frac{774}{1000}$	
	2 ½	0 $\frac{80}{100}$	0 $\frac{69}{100}$	Area is 0 $\frac{52}{100}$.
	2 ¼	0 $\frac{72}{100}$	0 $\frac{52}{100}$	

Sail-making may in ſome Meaſure be called Tayloring, the Difference being only this; the Taylor fits Garments for Men, Women and Children, and the like, and the Sail-maker fits Sails as Powers or Wings, to drive or draw all ſorts of Ships, Boats or Barks.

Biſhop *Wilkins* ſpeaking concerning Flying, tells us, that if a Perſon ever ſo heavy had Wings proportionable to his Weight, he might very probably fly as well as the ſmalleſt Bird; that is, if the Wings fitted to any Perſon's Body would cover a Body of Air Equiponderate to the Weight of the Perſon to whom they belong'd to, then ſuch Wings would as well bear ſuch a Perſon in the Air, as Bladders or Cork would bear up a Perſon in the Water, and keep him from ſinking.

It muſt be obſerved, that Air to Water is as 1 to 800, or thereabouts, ſo that 800 Foot of Air is but equal to 1 Foot of Water. The Weight of a Square Foot of Water is near 63 Pound, but a Foot of Air is not much above one Ounce and a Quarter.

The Weight of a Man, that is one with another, is near equal to 2 Foot and a half of Water, or 2000 Foot of Air; ſo that each Wing of ſuch a Man ought to be 1000 Foot, or 31 Foot $\frac{7}{10}$ Square; but the chiefeſt Difficulty would be to perſwade a Man to uſe ſuch Wings, and alſo to be brought to know how.

The Variety of Conſiderations that would be in ſuch an Attempt, I am perſwaded would not be found near ſo many as to well and truly ſuit a Ship with Sails fit and convenient, according to the Nature of her various Body, and to place them in ſuch a direct Poſition, that they might effect the Ship's Body, as well to force the Motion, as to Trim her well and make her Steer.

Sir *William Petty* in his Duplicate Proportion, ſays, that by wetting Sails the interſpers'd Apertures between the Threads are leſſen'd, and doth make the Sails, as it were, bigger; but he then alſo reflects, that ſuch important Poſitions are not minded and accounted for; nay, they are not ſo much as mention'd in the Writings and Diſcourſes of Ship-wrights, or Sea-faring Men.

Now this Reflection may lead us to one of the material Caſes which ought to be minded by the Sail maker, and that is to the Choice of good Canvas, which would be that which has the fineſt Threads, and is the cloſeſt and neateſt wrought; which muſt conſequently be the heavieſt and ſtrongeſt, and the Vacuities, as was afore mention'd, muſt be the leaſt, according to the Bigneſs of the Thread which the Cloth or Canvas is compoſed with.

There is a *French* Book publiſhed by the expreſs Command of the King at *Paris*, which has in ſome meaſure nicely conſidered the moſt advantagious Situation of the Sails in any Ship, according to the various Angle of Incidence of the Wind upon them.

He ſeems to reflect, treating of one Ship's chaſing another, and to miſs her, wherein, ſays he, one may eaſily ſee what ought to be obſerved when one gives Chaſe to a Veſſel which is to Leeward; for if on one Side to make more way you go more large, that is to ſay, if you for that Reaſon make a greater Angle with the Line of the Wind and Courſe, you ought to do it ſo as not to miſs your Chaſe; for which Reaſon you ought to compare the Quantity you fall to go to the Veſſel, to the Way you will make more than him in falling that Quantity; otherwiſe, ſays he, you will fall into the Inconveniency of what the *French* call *Engliſh* Chaſe, which is to ſay falling a Stern and going to Leeward; a very pretty Reflection this in a Scholar, ſince the *French* was never counted otherwiſe to the *Engliſh*.

The ſame Author proceeds, and tells you, that in the Crookeding of the Sails, ſome Part is ſo far from aſſiſting and forcing the Motion of the Ship, that it really is oppoſed and hinders the Ship; for, ſays he, it is to be noted, that the Difference of crookeding the Sails makes Ships hold the Wind more with their Top-ſails than with their Low ſails, and that it is impoſſible to get off from a Lee-ſhoar with the latter; and the Reaſon he gives is this, that the Top-ſails are ſtretch'd out by the great Yards as much as can be, before the Wind is let into them; ſo that the Wind can hardly make them crooked; but it is not the ſame with the Low-ſails, for as ſoon as you begin to ſtretch them, the Wind gets in and makes ſuch a great Curve, that you can ſcarce flat them; however, it is not by the Wind's getting in before the Sheets and Tacks are cloſe aboard and drawn to their Places, for that could be prevented, and done when the Sails are Shivering; but this Defect is chiefly cauſed by reaſon that the Ship's Breadth is much leſs than the Length of the great Yard, and conſequently the lower Part of the Sail muſt be haled more Curving than the upper Part, provided that the Sails are cut Square as uſual, and made as long at the Bottom as at the Top, or Head of the Sail.

And ſuch Conſiderations would put us upon ſhaping the Sails to the greateſt Advantage as could poſſibly be, to increaſe the Motion of the Ship, which is the ſecond principal Part that belongs to the Sail-maker's Art, there being one Part ſtill behind, which is to ſuit the Ingredients proper in compoſing the Sail, and bringing of ſuch Materials to general Heads; of which Part I ſhall be more particular at preſent than of the other two.

And firſt as to the Stitching Part, I find the common Allowance in the greateſt Extent is 108 Stitches in a Yard's Length, or 3 Stitches in every Inch; ſo that there is $\frac{1}{3}$ of an Inch between every two Needle Pricks, and the ſmalleſt Allowance is 90 Stitches in a Yard's Length, or 5 Stitches in every two Inches; ſo that there is $\frac{2}{5}$ of an Inch between every two Stitches.

Now as to the Reaſonableneſs of ſuch a general Number, as 108, 100, and 90 Stitches, and neither more or leſs in ſowing of Seams, I am of Opinion that no diſcreet Sail-maker will allow of it to be abſolute without farther Conſideration, and a more particular Guide to aſſiſt the Caſe; ſince there ought to be as much Regard to the Goodneſs of the Sail Cloth; the

Evenneſs and Strongneſs of the Twine; the exact Gauge of the Workman in nicely ſpacing his Stitches; the well joyning and equally ſtretching of the Cloth, that the Impulſe may have the like Effect upon one Cloth as it has upon the other.

Nay, to ſee to the Keenneſs and good Temper of the Needle, and that the Drill may be made in the interſpers'd Apertures, and not as near as poſſible to cut the Threads of the Sail Cloth.

However, I am not ſpeaking againſt ſetting the Workman a Bound to the Order of his Work; for indeed that ought to be in all Occupations; but am only prying into this Set of Number, and obſerving whether it agrees to Rule or not.

As to the Nature of a flat Seam, where 108 Stitches are allowed of in every Yard of Work, it muſt needs be more proper than the round Seams, provided that the Selvages be full ſtrong, and there be ſufficient hold taken of them in Sewing, ſince the round Seam can never be ſew'd ſo true, and that Ridge be laid ſo ſmooth and direct as the flat Seam can; and therefore every round Seam is as ſo many Stops, and oppoſed to the Motion of the Ship, and is alſo more liable to be rubb'd than the flat Seams are.

There ought to be a Regard had to the Strength of the Twine, that it be full as ſtrong and equal to the Strength of the Intervals which are between the Stitches, and as near as poſſible, that the Cloth be equal in Strength, Age, and Nature of the Soil where it was firſt producted; alſo that the Twine be as much like the Cloth, that it may (as *Vitruvius* ſays by Timber) ſympathize by a kind of Original Kindred.

And that in the repairing of Sails, ſuch Regard ought to be had not to mend Old Cloth with New, ſince the New will be more apt to ſtretch and bag with the Impulſe, being neither ſerviceable as to the Increaſe of the Motion, nor any ways ſtrengthning the Patch, but rather tearing the Old to pieces, much ſooner than if the Repair was made with Cloth of the ſame equal and alike Age to that which it patches.

That there may be a great deal of good Management uſed in ſhifting of Sails as they grow old, and putting them into Places which are not ſo often in Uſe, as where they were before; as to inſtance in Main and Fore Top-ſails, and Main and Fore Courſes, they are Sails which are generally uſed above all others, and alſo ſuch as are the principal Safe-guard of the Ship. Their Strain in the haling Tacks and Sheets are 3 to 1 more than the Sprit-ſail, Main Stay-ſail, nay Mizon and Mizon Stay-ſail, altho' at ſometimes a Ship is put to lye by under her Mizon; but then if the Sail is blown away, the Damage will be only the Loſs of the Sail, ſince it is the moſt eaſily ſhifted of any other Sail in the Ship; ſo that the Top-ſails and Courſes may be converted into ſuch Sails after they are very well worn.

But not reſting here, to ſhew what good Husbandry may be in ſuch Caſes, the large Ship's Sails may be ſo ordered, that after they are very well worn, they may be converted for ſmaller Ships; ſince the Strength requiſite will be according to the Area's there are between one Sail and another, which is as follows.

The Area's of a firſt Rate to that of a Third are as 4 to 3, ſo that when a firſt Rate's Sails are a Quarter worn, they may be converted to make Sails for a third Rate, and perhaps prove better at new working than at firſt, ſince all the damaged and defective Cloth will appear, and may be ſhifted.

The Area of the ſecond Rate Sails to that of a fourth is as 3 to 2; ſo that after they are $\frac{1}{3}$ worn, they will do after the ſame manner for the ſmall Ship. A third Rate to a fourth is as 4 to 3, and a third to a fifth is as 2 to 1; a fourth Rate to a fifth is as 3 to 2, and a fourth to a ſixth is as 9 to 5, and a fifth to a ſixth is as 7 to 6; beſides, there be Veſſels of a leſſer Denomination than what I have mention'd, as Fire-ſhips, Bomb-Veſſels, Hoys, Lighters, of ſeveral Degrees, all which, together with the daily Iſſues which are required in the Navy, as Awrings, Tarpawlins, painted Canvas, covering for Decks, Hammocks, and the like, manifeſt that there need not be ſcarce any Waſte made of the Publick Sail Cloth, or that continual common and moſt conſuming Cuſtom of ſelling the Publick Sail Cloth at common Sales, a Matter ſo general, that it's impoſſible for His Majeſty's Officers to know whether His Majeſty's ſaid Store is ſold or imbezzled; nay, according to the common Cuſtom, it will be very hard to define whether our very large Navy's Sail Cloth is not uſed for moſt of the Merchant's Shipping, ſince the Mark that diſtinguiſhes it is ſo eaſily taken out.

But perhaps it may be objected, that the Charge of taking large Sails to pieces, and new Sew them, will be more conſiderable than to buy new; but that is ſoon anſwer'd, for the Sewing is but the ſame as it will be charged to you in making new Sails, beſides buying the Cloth.

Another Objection may be, that perhaps Ships Reparations may not ſo nicely jump together, and that one Ship's Sails may not be in a Condition to be ſhifted when the other Ship doth neceſſarily require it. But to this may be anſwer'd, that no Man would be guilty of courting Impoſſibilities, neither would I be thought guilty of propoſing Methods that could not be comply'd with: Notwithſtanding, if it cannot be done throughout the Navy, it's hard if it cannot be done in half, or if not in half, it would be a great many Thouſand Pounds in the Governments way, if it could be done in a Quarter Part of our large Navy; ſince you may ſee by the Number of Yards of Canvas which is converted to Sails in the ſix Sizes, from a firſt Rate Ship to a ſixth, is at leaſt 15645, and it cannot be thought any ways proper for any Ship to go to Sea with leſs than two ſuch Suits of good Sails, which then would be double the Number, or 31290 Yards. I ſhall count this at 3 *s. per* Yard for Cloth and making, the Sum will be 4692 Pounds for ſix Ships; but it's believed that the Navy of *England* has of one ſort or another 200 Sail of Shipping belonging to it, and then the Sum of Money to find them two Hundred Sail of Ships Sails proper and convenient to proceed to Sea, will be 154836 Pounds, and half ſuch a Sum I preſume may be got or loſt thro' good or ill Management in three or four Years time. Not that I would have any one to imagine, that I have been nicely inſpecting or calculating the exact Quantity of Canvas, or what the Sum has or is likely to be for doing ſuch a Part of the Marine Publick Service, but only by the way I thought proper to hint this moſt important Poſition, believing, and being almoſt poſitive I am not far off from the Matter of Fact, either one way or another.

In the next Place I ſhall proceed to conſider of the Nature of binding the Sails, or of the Bolt-Rope.

The Bolt-Rope is a binding Bar, or Fence for the Sail, ſuch a Safe-guard, that it's very probable if it was not for ſuch a binding Rope, a Sail would not be for Uſe or Service. How this Rope was firſt ſized I cannot ſay, whether by a Rule, or attain'd to the Perfection it's at by Experience; however, I am of Opinion, that there may be Detriment as well in under-ſizing as over-ſizing ſuch a Material, and I therefore ſhall conſider this Caſe, and give my Opinion of it as follows.

Firſt, I ſhall conſider of the particular Area's of the Main Sails, from which I preſume all other Sails Area's may be depended on.

Then × 19 by 32, it's 608 for the Area of a firſt Rate's Main Sail in Yards.

32

38

57

608

Then × 18. 5 by 31, it's 573. 5 for the Area of a ſecond Rates Main Sail in Yds.

31

185

555

573. 5

Then × 16 by 27, it's 432 for the Area of a third Rate's Main Sail in Yards.

16

162

27

432

Then × 14 by 23, it's 322 for the Area of a fourth Rate's Main Sail in Yards.

14

92

23

322

Then × 11. 5 by 19. 5, it's 224.25 for the Area of a fifth Rate's Main Sail in Yds.

11. 5

97. 5

195

195

224.25

Then × 11 by 16, it's 176 for the Area of a ſixth Rate's Main Sail in Yards.

11

16

16

176

And theſe particular Calculations agree, one to another near enough, for our preſent Work, to our general Calculation of the whole Quantity of Canvas I deem to be proper for to make Sails for each Rate.

The firſt Rate's Main Sail, containing 608 Yards multiply'd by 9 is 5472 Feet, and ſo many Feet being contain'd in the ſuperficial Area of the Main Sail, is equal to ſo many Ounces and Quarters of Air, which is 6840 Ounces, or 527 Pound and a half, which is a Weight much inferiour to the Weight of the Sail, and therefore here muſt be an Impulſion of Air to cauſe a Crookedneſs in the Sail, and forcing the Ship forward, as it may be obſerved in gentle eaſy Gales, that the Sails reverberate, and are never ſteady till the Impulſe of Wind is more Ponderous, and an over Ballance for the Weight of the Sail; which is the chief Reaſon that ſmaller Bodied Ships are ſooner effected with a little Wind, than thoſe that are bigger; and it would be really very Diverting to make Tryals of this Natural Cauſe; and obſerve the Increaſe and Decreaſe of the Air's Weight, by the different Degrees of Swelling that may be obſerved in Ship's Sails, whoſe Superficial Area's may be ſome bigger and ſome leſſer, and at the ſame time very near together; nay, it may be alſo ſeen in the ſame Ship, by the upper and lower Sails, what Difference there is in the Air's Weight in the different Heights between the Atmoſphere and the Horizon; but to proceed,

As to the different Degrees of Impulſe, it will be very hard to define them, and how and in what manner the Sails are affected by the Violence of the Wind, it being really very amazing to ſee what Difference there is between a moſt clear and ſerene Calm, when as it's term'd there is ſcarce, or not one Breath of Wind, and at another Time when the Air is ſo violently agitated, that without the Help of any Sail, the moſt huge large bodied Ships which are now in being, are almoſt blown beyond the Water's ſtopping of them.

The Air, as it's obſerved by our famous Writers, is a ſpringy Reſilient Body, or made up of Bodies that are almoſt in the Nature of a Watch's Spring, endeavouring to unrowl themſelves, and become ſtreight; but being hinder'd by Bodies of the ſame Make and Form, are hurried and drove one to the Hindrance and Retarding of the other.

Now the beſt and moſt familiar Way that I ſhall account at preſent for this extream Impulſion of the Wind upon the Sail, is to allow it as in the Caſe of the Water's Reſiſtance upon the Ship's Bows, or Foremoſt Part, which is, that this Impulſe of Wind upon the Sail in the greateſt Extremity, ſhall be equal to half that Solid which ſhall be compoſed by multiplying the Length of the Sail by the Depth, and again by a ſquare Number made by that Length and Depth; not that I have ſuch an undeniable Maxim to fix this Principle upon, as there is in the Caſe of the Reſiſtance of the Water upon the Ship; ſince the Ship is at the Top of the Water, and on the other Hand is wholly under the Force of the Air, and therefore I believe that this Weight and Force of Air ought to be accounted for from the Atmoſphere's Height to the Object it vaporates upon; however, I ſhall firſt ſet down the Weight that this Sail may be expected to bear by the aforeſaid Calculation.

608 multiply'd by $24\frac{6}{10}$, it's 15256. 8, which being halfed, is 7128. 4 Yards multiply'd by 9, is 64155. 6 Feet, or ſo many Ounces and a quarter.

And by ſuch a Calculation it's found that the Weight of Air that affects the firſt Rate's Main Sail is 5012 Pound, which will be but equal to 79 Feet of Water and $\frac{35}{63}$ Parts, which can never be the Weight of the Air that affects ſuch a Sail in the greateſt Extremity, and therefore I ſhall endeavour to find a new Calculation to ſuit this Work.

The healing of a Ship might in ſome meaſure paint out to us an Idea of this Force or Impulſe on the Sail, it being accounted for that it requires more Force to make a Body revolve, than it doth to cauſe the ſame Body to make a ſliding Motion; nay, the rowling and tumbling of the Water may aſſure us that the Force of Wind is very great to cauſe ſuch a ponderous Body to make ſuch huge large Waves, as may ſometimes be obſerved between two Summets, as the upper Ridges of the Waves are term'd; but to wave ſuch Diſcourſe, I ſhall conſider what Weight of Air may be between the Atmoſphere and the Object.

The Atmoſphere is the lower Part of the Region of the Air with which our Earth is encompaſſed all round, and into which the Vapours are carried up either by Reflection from the Sun's Heat, or by being forced up by the ſubterraneous Fire.

The Preſſure of the Atmoſphere Mr *Boyle* undertakes to demonſtrate from many Experiments.

The Height of the Atmoſphere is variouſly conjectur'd: *Kepler* makes it about 8 Miles, but *Ricciolus* makes it probably at leaſt 50 Miles high; Mr. *Boyle* makes the common Height of the Atmoſphere when the Mercury in the Boroſcope is at 30 Inches to be 35000 Feet, or 7 Miles; but this is upon a Suppoſition, that all our Air is of the ſame Denſity and Weight from the Surface of the Earth to the Top of the Atmoſphere.

The ſame Honourable Philoſopher, by an Experiment mentioned in Dr. *Harris*'s Dictionary, allows that a Column of Air 1 Inch in Diameter and 3 Inches long, weighs 14 Pound 2 Ounces, and above 3 Drams of Mercury *Troy* Weight. Hence, ſays he, knowing the Proportions of Cylinders, 'tis eaſy to calculate the Weight of a Cylinder of Mercury, and conſequently of Air to the Top of the Atmoſphere of any given Diameter; for as 1, the Square of the Diameter of the Cylinder above mentioned, is to the Square of the given Diameter of the Cylinder ſought.

In Mr. *Boyle*'s Deſcription of his Statical Baroſcope he tells us, that he found a Pillar of Air incumbent on a Square Inch, to weigh 48 Pound 1 *Troy*, from which Account the Weight of the whole Air all round the Globe is counted to be 8,990,405,732,208,000,000 Pound *Troy*.

Mr. *Hally*, by undoubted Experiments, found, that the Weight of Mercury to Water is as 31 $\frac{1}{2}$ to 1, or very near, and that the Specifick Gravity of Air to Water is as 1 to 800, ſo that the Weight of Mercury to Air is as 10800 to 1; and that a Cylinder of Air of 10800 Inches, or 900 Feet, is equal to 1 Inch of Mercury; ſo that were the Air of an equal Denſity like Water, the whole Atmoſphere would be no more than 5 $\frac{1}{10}$ Miles high.

The Wind is defin'd to be a Stream or Current of the Air, and where ſuch Current is perpetual, and fix'd in its Cauſe, 'tis neceſſary that it proceed from a permanent unintermitting Cauſe.

Then if a ſquare Column of 1 Inch has 18 Pound $\frac{1}{8}$ Weight incumbent upon it, what may ſuch a large Ship's Main Sail, which is 787968 Inches, and that brought into 18 Pounds $\frac{1}{8}$ is 14177980. 16 Pounds, which is equal to 225110. 79 Feet of Water; but the Water that reſiſts ſuch a great Ship is 16800 Feet, and the Water that bears her at her lighteſt Draught of Water is 66296, and it being found from Experience, that 66296 Feet of Water is but equal to the Weight of the Ship it ſo bears, therefore we plainly find that the Ship is but little affected with the Weight of the ſtill and gentle Air, before its diſturbed and drove into violent Motions.

By Mr. *Hally*'s Obſervation its found that a Cylinder of Air containing 900 Feet, is but equal to a Cylinder of Mercury of 1 Inch Diameter, ſo that 900 Feet of Air is but equal to 14 Pound 2 Ounces 3 Drams, and by this Obſervation the Weight of Air on ſuch a large Ship's Sail is 714 Pound 11 Ounces 7 Drams, and this is the Weight of the ſtill Air before it is moved or provoked to Motion.

Area's of the Sail. Yards.	The Square of the Diameter of the Bolt-Rope. Inches.	The Diameter of the Bolt-Rope. Inches.	The Circumference. Inches.
3969	3 7/10	1 92/100	6
3660	3 17/40	1 85/100	5 3/4
3680	2 17/20	1 68/100	5 1/4
3000	2 31/40	1 66/100	5 2/10
2950	2 29/40	1 65/100	5 2/10
2850	2 25/40	1 62/100	5 1/20
2750	2 21/40	1 58/100	4 19/20
2650	2 17/40	1 56/100	4 9/10
2550	2 13/40	1 52/100	4 3/4
2450	2 9/40	1 48/100	4 6/10
2350	2 5/40	1 46/100	4 11/20
2250	2 1/40	1 42/100	4 1/2
2150	1 94/100	1 38/100	4 7/20
2050	1 85/100	1 36/100	4 1/4
1900	1 76/100	1 33/100	4 3/20
1800	1 66/100	1 27/100	4
1700	1 57/100	1 23/100	3 8/10
1600	1 48/100	1 22/100	3 7/10
1500	1 38/100	1 18/100	3 3/4
1400	1 29/100	1 14/100	3 11/20
1300	1 20/100	1 10/100	3 4/10
1200	1 11/100	1 5/100	3 1/4
1100	1 1/100	1 1/100	3 1/10
1000	0 92/100	0 96/100	2 39/40
900	0 83/100	0 91/100	2 9/10
800	0 74/100	0 86/100	2 14/20
700	0 64/100	0 80/100	2 5/10
600	0 55/100	0 74/100	2 3/10
500	0 46/100	0 67/100	2 4/40
400	0 37/100	0 61/100	1 9/10
300	0 28/100	0 54/100	1 68/100
200	0 19/100	0 44/100	1 38/100
100	0 95/1000	0 31/100	0 98/100
90	0 86/1000	0 29/100	0 90/100
80	0 76/1000	0 27/100	0 85/100
70	0 67/1000	0 26/100	0 82/100
60	0 57/1000	0 25/100	0 78/100
50	0 48/1000	0 22/100	0 69/100
40	0 38/1000	0 19/100	0 60/100
30	0 29/1000	0 17/100	0 53/100
20	0 19/1000	0 14/100	0 44/100

And here is a Bolt-Rope ſized from the biggeſt Ship's Main Sail, to a Sail that the Superficial Area will not contain as much Canvas as will make a ſmall Boat a Main Sail, it being but 20 Yards, which is little more than 6 Yards and a half long, and 3 Yards broad: For you are to underſtand that theſe Superficial Area's is not according to ſo many Yards by the Breadth of every Cloth, but ſo many Yards Square, ſince no Sail-Cloth as ever I could obſerve, contains more than 3/4 of a Yard Breadth, or thereabouts; but that is not to our Inquiry: For as you may obſerve this Method of reducing the Bolt Rope, which will really be the right, according to the Impulſe or Streſs upon each Sail, will allow but of a very ſmall Rope for the little Sails, ſince a Sail, whoſe Superficial Area contains 20 Yards, the Bolt-Rope appears by this Calculation not half an Inch in the Circumference, as you may ſee it is but 44/100, the Diameter of which is but 14/100, little more than 1/8 of an Inch. A much ſmaller Rope, I preſume, than ever was apply'd to make a Bolt Rope for the ſmalleſt Boat; and therefore in the next Place I ſhall conſider a little further of the Application of the Bolt-Rope, according to the Weight of the Sail Cloth, and Number of the Sails.

It is as common, as any one Part of the Marine Diſcipline to ſee a ſmall Boat and a large Ship's Canvas of one Subſtance, and if not of the ſame Species, the Difference will be very ſmall, which cauſes that large Difference which is found in the Area's of Boats Sails to the Area of a Ship's Sails; for according to my preceeding Obſervation of the Proportional Quantity of Canvas, which I deem needful, to be apply'd to any Veſſel's Sails, nay, what in Reality moſt Ships have allowed them, or rather more, a Boat of 20 Foot long ought to have 4634 Yards of Canvas converted into her Sails, and not only 400 Yards of Cloth according to a running Meaſure, but a Superficial Area of 68 multiply'd by 68 Yards; when it's very rare to ſee in ſuch a Boat's Sail above 25 Yards, which is little more than half ſuch a Quantity; ſo that I preſume the Number of Yards is made up with the Thickneſs of the Cloth, and of Conſequence the Bolt-Rope ought to be allowed of, according to what Number of Yards there ſhould be in the Number of Sails, and not according to what Number of Yards there are, ſince it plainly appears, that the ſaid Number, according to the Square made, by multiplying the Length of the Boat into its ſelf, is made up by the Thickneſs of the Sail Cloth, and then the Rope ſuitable to make a Binding for ſuch a Boat's Sail will be $\frac{67}{100}$ of an Inch Circumference, whoſe Diameter will be $\frac{22}{100}$, almoſt $\frac{1}{4}$ of an Inch; and by ſuch a Rule may be found the Dimenſions of the Bolt-Rope ſuitable and agreeable for any ſmall Boat's Sail. But as to the Goodneſs of the ſmall Rope in Proportion to great, I ſhall particularly conſider of it when I come to the Branch of Rope-making, though there ſhould be ſomething ſaid to the Goodneſs and Magnitude of the Twine in Proportion to the Strength of the Canvas, and Quantity of the Area contain'd in the Sail; but I ſhall wholly refer it, till I come to that Part of the Rope-making in general.

I ſhall end this Part with juſt mentioning what a Sail-maker may reaſonably earn in a Day, according to the Allowance aforementioned.

Firſt, he is allowed for flat Seams in Duck, *Suffolk*, and the like Sail Cloth 3 *d.* $\frac{1}{4}$ for every Yard he ſews, and to put in from 108 to 90 Stitches; however, I ſhall allow of 100 Stitches in the Medium. Then from Four to Eight, only taking out 2 Hours for Breakfaſt and Dinner all the Year round, there will be 14 Hours, which multiply'd by 60, makes 840 Minutes; and provided a Man can make 5 Stitches in the hard Canvas every Minute, and hold it; and in conſideration the round Seam'd Cloth is generally ſofter than the other, I ſhall allow that he may make one Stitch more in a Minute, which is 6; then he will earn at ſewing the hard Cloth 11 *s* 4 *d.* $\frac{1}{2}$ per Day, and for the other 12 *s.* 10 *d.* per Day.

But provided, that inſtead of working from Four to Eight, he works from Six to Six, and allowing 1 Hour and a half for Breakfaſt and Dinner, it's 10 Hours and a half, which multiply'd by 60 it's 630 Minutes; then at the ſame Allowance of 5 Stiches in a Minute for the thick Canvas, and 6 Stitches in thin, the Sailmaker earns on the former 8 *s.* 5 *d.* $\frac{1}{2}$, and on the latter 9 *s.* 7 *d.* $\frac{1}{2}$, and it's very probable he may comply with ſuch a Number of Stitches in ſuch a Time, and do his Work very well.

OF THE
Glazier's CONTRACT.

For Green Glaſs.

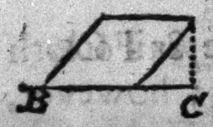
	d.	
FOR new Squares ſet in Lead	9	*per* Foot Square.
Ditto in Saſhes, finding Putty	7½	
Diamond Panes ſet in Lead	6	

New Squares of all Sizes for Repairs at 4 *d.* each.
Diamond Quarries for Repairs at 9 *d.* *per* Dozen.

Old Glaſs new Leaded	2½	*per* Foot.
Old Glaſs new banded and ſolder'd	1½	

Stone Ground Glaſs.

Inch.		s.	d.	
9	Long or under	1	6	each.
10		2	0	
11	With half in the Medium, each Pane	2	3	
12	to be put into the Frame with Putty, and	3	0	
13	all to be the Breadth within 2 Inches of	3	9	
14	the Length, and to be meaſured upon the	4	0	
15	Square, tho' the Shape be as in the Figure	6	0	
16	A.	8	0	



Meaſure the Length of ſuch ſhaped Panes of Glaſs from B. to C.

	s.	d.
From 17 Inches to 13 Inches long	7	0
Ditto 18 to 14	9	6
Ditto 18½ to 16½	11	0
Ditto 18 to 16	9	6
Ditto 17½ to 15½	8	0
Ditto 17 to 15	7	0
Ditto 16½ to 14½	6	3

This Agreement was made the 29th of *January*, 170½.

Muſcovia Glaſs, and Tin or Latten Work.

Diameter.		Height.		Obſervation.	Value.		
Ft.	*Inch.*	*Ft.*	*Inch.*		*l.*	*s.*	*d.*
4	0½	7	0	Raking Globe Lanterns.	15	10	0
3	9	6	6		13	10	0
3	5½	6	0		11	10	0
3	2	5	6		10	00	0
2	10	5	0		8	10	0
2	7	4	6		7	00	0
2	3½	4	0		6	00	0
2	0½	3	6		4	18	0
1	9	3	0		4	00	0
1	5	2	6		3	06	0

Diameter

Diameter.		Height.		Obſervation.	Value.		
Ft.	*Inch.*	*Ft.*	*Inch.*		*l.*	*s.*	*d.*
4	0½	7	0	Upright Globe Lanterns.	11	00	0
3	9	6	6		9	08	0
3	5½	6	0		8	05	0
3	2	5	6		6	15	0
2	10½	5	0		5	10	0
2	7	4	6		4	10	0
2	3½	4	0		3	10	0
2	0½	3	6		2	10	0
1	9	3	0		1	17	0
1	5	2	6		1	04	0

	l.	*s.*	*d.*	
White Plates Double	0	9	6	*per* Dozen.
White Plates Single	0	5	0	
Whole *Ruſſia* Glaſs	0	12	0	*per* Pound.
18	0	9	0	each.
16	0	7	0	
Tin Trucks of 14 Inches Diameter.	0	6	4	
12	0	5	4	
10	0	4	6	
Large Hand Lanterns of Tin and Horn of 7 Inches Diameter, and 14 Inches high to the Neck.	1	10	0	*per* Dozen.
Solder	0	0	9	*per* Pound.
Iron Wire	0	0	8	
Screen Wire	0	1	4	*per* Ft. Square.
Wire Files for Paper	0	0	3	each.
Diamond *Muſcovia* Glaſs ſet in gilt Plates 3 Inches Square, none leſs than two Inches and a half Square.	0	3	6	*per* Foot.
Ditto ſet in White Plates	0	3	2	
Diamond Panes for Repairs	0	0	2	each.
Lantern Panes for Repairs	0	0	4½	each.
Hinges for Scuttle Lights of Tin	0	0	2	*per* Pair.

Glazing is rather for conveniency to accomodate Places, than any ways for Strength or Service.

To make Houſes conſpicuous and delightſome, which otherwiſe would be dark and obſcure, provided the Weather, as Wet and Cold, was kept out.

Our Improvements in Glaſs have been extraordinary ſince my Remembrance, for the ſame very Manufactures that formerly ſupply'd us with Glaſs, are glad to accept of that very Commodity from us.

You may obſerve in the firſt Place, it is ſaid for new Squares ſet in Lead the Value is 9 *d. per* Foot Square, and for the ſame Sort ſet in Saſhes 7 *d.* ½ *per* Foot; ſo that the Difference is 1 *d.* ½ more for the Lead and Workmanſhip than for the Putty.

Then for the Diamond-faſhion Work, the Figure of our common Houſe Windows, the Price is but 6 *d.* per Foot, ſo that either the Nature of the Glaſs muſt be diverſe, or otherwiſe the Prices are not nicely conſidered, ſince, as I ſhall more fully illuſtrate of the Stone Ground Glaſs hereafter, the Waſte in cutting the Diamond faſhion Glaſs will be more than in cutting the Square Glaſs.

Then the Price of new Squares of all Sizes for Repairs is 4 *d.* each, and Diamond Quarries for Repairs is 9 *d.* per Dozen.

You

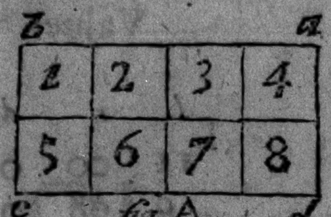


fig A

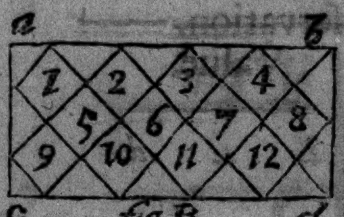


fig B

You may obſerve in theſe two Figures, the Difference in cutting Square Glaſs and Diamond Quarries; both Figures I allow, when entire, to be each 2 Foot on the Superficies, and according to the cuſtomary Bigneſs of Diamond Quarries, they are 6 Inches deep and 4 ¾ broad, from Corner to Corner; but if you meaſure them Side-ways, they are near 3 Inches and ⅞, the Number of Quarries that are cut out of two Foot of Glaſs is 18, counting the half Quarries, which are as uſeful to the Glazier as the other whole Quarries, and muſt (as you may plainly obſerve) be put in to make the Pane, or Piece of Glaſs entire.

The Value of this Piece of Glaſs, when it is leaded, banded, and ſolder'd, nay, and put in it's place too, will be 1 *s.* but if the Glazier ſells the Quarries ſingle handed, without Lead, Solder, or Labour, he is to have 13 *d.* ½ Penny; which brings me farther to conſider of the common Repairs in old Glaſs, and what Advantage the Glazier makes that way, only firſt I ſhall put you in mind to obſerve the Figure A, that according to the Depth and Breadth of the other Quarries in Figure B, there will be but juſt half that Number, or 8; ſo that the Value will be juſt as 2 to 1, if the Quarries are ſold without any Workmanſhip applied to them; but if the Figure A is made up into ſuch a Piece of Glaſs, then the Price *per* Foot cannot be more valuable than the ſame Superficial Inches of the Diamond-faſhion Glaſs; nay, the Workmanſhip will not be ſo much in A, as in B; ſince the Number of Panes will be as 2 to 1, and alſo the Lead in A, will be much leſs than the Lead in B, and conſequently the Soldering.

Muſcovy Glaſs of the ſeveral Dimenſions.

Length.	Breadth	PriceFt Square.		Each Pane.		Length.	Breadth	PriceFt Square.		Each Pane.	
Inches.	*Inches.*	*s.*	*d.*	*s.*	*d.*	*Inches.*	*Inches.*	*s.*	*d.*	*s.*	*d.*
6	6	5	00	1	03 ½	4 ½	4 ½	4	06 ½	0	7
6	5	4	11	1	01 ¼	4 ½	4	4	00	0	6
6	5 ½	4	09 ½	1	00 ½	4	3 ½	3	10	0	5 ¼
5 ½	5	4	08 ½	0	10 ¼	4	3	3	09	0	4 ¼
5	5	4	08	0	09 ¼	3	3	3	03	0	3 ¼
5	4 ½	4	07 ½	0	08 ¼	4 ½	4	4	05 ½	0	6 ½
5	4	4	07	0	07 ½	3	2 ½	3	02	0	3

	s.	*d.*	
For faſtening of Double or Single Tin Plates, and finding Nails for the ſame, whether in Bread-Rooms or on Galleries, or Fire Hearths —— —— ——	1	6	per Dozen.

January, 1701-2. for Raking Poop Lanterns with Stone Ground Glaſs.

Length.		Diameter.		Value.			
Ft.	*In.*	*Ft.*	*In.*	*l.*	*s.*	*d.*	
8	2	4	2	23	00	00	
6	7	3	6	18	10	09	
6	6	3	8	18	06	01	
8	2	4	0	23	00	00	each.
7	0	3	6	19	04	03	
5	6	3	0	15	09	09	
6	0	2	10 ½	16	18	00	
4	8	2	5	13	02	10	

Theſe foregoing Conſiderations put me in mind of a common Saying amongſt ſome People that have employ'd Glaziers; they tell you, that it would be much better, if your Glaſs is grown much out of Repair, to heave it away, and buy new, than to repair the old; I ſhall therefore give you my Opinion how far this may be allowed reaſonable.

In Caſe you have a Piece of Glaſs that contains 2 Foot, as in the Figure, and that the Quarries contained in ſuch a Piece be 18, and 12 of them broke; however, you may imagine that the 6 whole Quarries and the old Lead may make the Charge of mending ſomething eaſier, to Work the Glazier goes, and when he has done, he will count for his 12 Quarries 9 *d.* for new Leading (altho' perhaps he has new ſet ſome of the old) 2 *d. per* Foot, which will be 4 *d.* and for new Bandings 1 *d.* ½ *per* Foot, which in all will be 16 *d.* and for 12 *d.* you might have had the Glaſs and Lead every Inch new; beſides, the old Lead you may depend is ſhrunk, as the Nature of Lead is to do by heat; ſo that if but 6 Quarries of your old Glaſs is broke, and the Lead bad, you had better to heave it all away, and have new Glaſs entire.

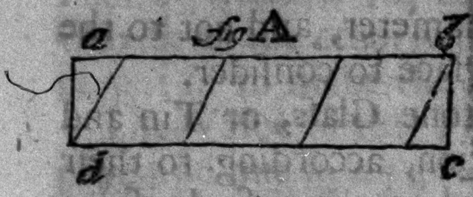
I ſhall proceed now to conſider of the Stone-ground Glaſs, which at this time is very brief amongſt us, and ſet in Wood without any Lead.

And ſuch Glaſs ought to be nicely conſidered as to its Strength, as well as to the Clearneſs and Niceneſs of the ſame; for if one Pane be 9 Inches Square, and the other 9 Inches broad and 18 long, then that of 18 Inches long ought to have double Thickneſs to make them equally ſtrong, and then there will be 4 times as much Glaſs in one as in the other; and if it be reaſonable for the Price of Glaſs to be adjuſted by the Pound, then the Price ought to be as 4 to 1.

I will allow then, that a Pane of 18 Inches Square ſhall be twice as thick as one of 9 Inches Square, and of conſequence be 8 times the Price; which Proportion ſhall adjuſt the Price of all other Sizes, as may be ſeen in the following Table.

Inches. The Square of each Pane	The Thickneſs of each Pane in Parts of an Inch.	*Inches.* Area of the Glaſs Panes, with equal Thickneſs.	*Inches.* Additional Area or Content cauſed by the Extra-Thickneſs, which, as they are one to another, ſo ought the Price to be adjuſted.	*s.* The Price of each Pane according to ſuch a Rule	*d.*
9	8/64	81	81	1	6
10	9/64	100	112 ½	2	1
11	10/64	121	151 ¼	2	9 ½
12	11/64	144	198	3	8
13	12/64	169	253 ½	4	8 ½
14	13/64	196	319	5	10 ½
15	14/64	225	394	7	3 ½
16	15/64	256	481	8	11 ½
17	16/64	289	578	10	7 ½
18	17/64	324	688 ½	11	9

And by ſuch a Method may the Price of Stone-ground Glaſs be adjuſted, as well as by any Method whatever, except by weighing of it, and that for the Figures on the other Side will not do, becauſe of the Waſte which is made by ſhaping a Rhombus; notwithſtanding I cannot ſee how it is abſolutely reaſonable for the Glaſs-man to expect ſuch an Allowance as is mention'd of the other Side for every Quarry, except every Quarry was full as large as the whole Piece of Glaſs, at it's being firſt Run out of the Furnace; and if it is as big, then it would be as proper to run it to the exact Shape of ſuch Figures, and by that means there would be no Waſte at all that ſhall call for ſuch an Allowance; but if ſuch a Cuſtom cannot be, the Waſte will not be according to what is mention'd of the other Side.



For in Caſe there was three Rhombus Panes to be cut out of a Piece of Glaſs of the Bigneſs that the Parallelogram *a. b. c. d.* is of, then that Waſte which is made by ſhaping a Rhombus out of a Square Piece of Glaſs, will be only at each end, and inſtead of allowing the Waſte to every Quarry, it ought to be allowed between the three Quarries, ſo that every Pane ought to have but $\frac{1}{3}$ of ſuch an Allowance added unto it; but this Matter will appear, if rightly conſidered, ſo very various, that it would be much better for thoſe that uſe ſuch ſort of Shape Glaſs, to ſee the whole Piece cut out, and that will truly guide them in what Waſte is made, by ſhaping it ſo; for ſuch ſhap'd Quarries only happen in Ship-work, and on the Gallery Lights. I ſhall paſs on now to conſider ſomething of the Poop Lanterns, and adjuſt their Prices according to the various Area of each.

You may obſerve a great Difference in the Prices of upright Lanterns, and of ſuch as are Raking, or in the Nature of a *Rhombus*, according to the faſhion of the Ship's Stern on which they are placed. I ſay the Difference is very wide, altho' the Dimenſions are directly equal; but of that I ſhall not at preſent Inquire; neither ſhall I Inquire into what Difference there is in the Proportions, from the Variety there is found in their ſeveral Dimenſions, only ſhall juſt hint ſomething of that Nature, and paſs on to the Lanterns, or rather Poop Lights that are made with Stone Ground-glaſs.

You may obſerve that the Price of a Raking Tin Lantern of 7 Foot high, and 4 Foot and half an Inch Diameter, is 15 *l.* 10 *s.* and one of the ſame Bigneſs that is upright is ſold for 11 *l.* ſo that their Prices are as 7 to 5; and this Difference I preſume was allowed the Maker for his new faſhion Cut, and that Symmetry of Shape in ſuch Lanterns, more than what is found in the other.

The Price of ſuch a Raking Lantern of 3 Foot 6 Inches long, and 2 Foot and half an Inch Diameter, is 4 *l.* 18 *s.* and for an upright Lantern of the ſame Dimenſions the Price is 2 *l.* 10 *s.* which is near as 2 to 1; ſo that the Difference in the Price is very wide, altho' their reſpective Dimenſions are exactly equal, which I am in the next Place to enquire into.

Firſt, in comparing the large Lanterns to the ſmall, I find the Heights and Diameters as 2 to 1; then the Superficial Area is as 4 to 1, and by conſequence the Tin and Glaſs to make the ſame will be as 4 to 1, if the Tin in each be of equal Thickneſs, which I cannot allow to be reaſonable.

The Price in the Raking Lanterns is as 19 to 6, or near as 3 to 1, and in the upright Lanterns as 22 to 5, or more than as 4 to 1. Now if the Price in the Raking Lanterns was according to their various Superficies, the Price of the large Lantern muſt be 19 *l*, 12 *s.* or the ſmall one but 3 *l.* 17 *s.* 6 *d.* ſo that here is allowed for faſhioning more in the ſmall Lantern than in the great, according to the Variety of their Superficies, which I take to be very unreaſonable here, ſince it's very probable that the Number of Pieces put to make them Lanterns may be equal, and the Difference in making only will be found in Soldering, which will be but ſmall.

The Price in the upright Lanterns is as 4 to 1, according to the Variety of their Superficies; ſo that here the Allowance for faſhioning the ſmall Lanterns, is agreeable to the Quantity of the Material put to make them: However, I ſhall paſs on, and more particularly conſider of this Property in the Prices and Dimenſions of the Stone-ground Lights; which, altho' dearer at the firſt purchaſing, will moſt certainly be ſound cheapeſt in the Wear and Uſe.

The Price of a Stone-ground Light of 8 Foot 2 Inches long, and 4 Foot 2 Inches Diameter, is 23 *l.* and the Price of one of 4 Foot 8 Inches long, and 2 Foot 5 Inches Diameter, is 13 *l* 2 *s.* 10 *d.*

The Lengths are as 7 to 4, and Diameters are as 7 to 4, then the Superficial Area is as 14 to 4, not quite as 4 to 1.

The Price is as 7 to 4 in direct Proportion to the Diameter, and not to the Superficial Area; of which Matter I am in the next Place to conſider.

Such Lights may be either made with Wood and Stone Glaſs, or Tin and Stone Glaſs; and if they are made in direct Proportion, according to their different Magnitude for Strength, the Material applied to compoſe the ſame ought to be as 28 to 4, or as 7 to 1, ſince the Superficial Area's are as 14 to 4; and why the Price ſhould be as 7 to 4, or near as 2 to 1, I profeſs is a Paradox to me.

As to the making, provided that the Number of Bars, Stiles, and every Piece of Framing Work, is equal the Work in the large (were they only to be conſidered as to their double Length) muſt of Conſequence have twice the Labour as that in the ſmall Lantern or Light; but as the Superficies are one to another as 14 to 4, the Work in one may reaſonably be expected to the Work in the other, according to ſuch a Proportion; however, I ſhall allow the Workmanſhip to be but as 3 to 2, conſidering that the Number of Pieces will be equal, and therefore the faſhioning in one may be almoſt equal to the faſhioning in the other in ſuch pieced and ſpliced Work.

Well then, let the Quantity of Material be but 5 times as much in the large as in the ſmall Lantern, or Light, and the Workmanſhip as 3 to 2, the Price will be found by the Compound Fraction of $\frac{1}{5}$ of $\frac{2}{3}$, which is $\frac{2}{15}$; ſo that inſtead of allowing the Price to be as 7 to 4, it ought to be as 15 to 2; ſo that either the Price of the ſmall muſt be but 3 *l.* 2 *s.* or the Price of the large ought to be 98 *l.* which great Diſproportion, for want of a true Mechanical Notion in making ſuch large Lanterns, is the true Reaſon that ſuch great Lights decay ſooner, and will not laſt near ſo long as Saſh that are ſmaller, and by conſequence much ſtronger.

You may obſerve, that double Tin Plates (as they are term'd) are 9 *s.* 6 *d.* *per* Dozen, and ſingle ones but 5 *s.* *per* Dozen, which is near as 2 to 1; however, it's not to be ſuppoſed that the double Tin Plate's Superficial Area is juſt twice as much as the ſingle: No, the Subſtance is alſo in Proportion to their various Superficies, and therefore will not ſpread or cover twice the Number of Inches; ſo that was you to have a Piece of Work made with double Tin Plates, and another Piece of Work made with ſingle Tin Plates, the Price ought not to be only adjuſted by the bare Superficial Content, but alſo by the extraordinary Thickneſs, and by conſequence Strength cauſed by the double Tin Plates.

Of the Nature of the CONTRACTS of the BRASIER, FOUNDER, and PLUMMER, put together.

And in other Contracts the Species has been at the following Price.

	s.	d.		s.	d.		s.	d.	
Bells { Cabbin	1	9	per Pound	1	6½	per Pound.	1	7	perPound
Bells { Watch	1	1¾		1	1¾		1	2	
Braſs Rowls } For Pumps	1	1	per Pound						
Cocks for Furnaces	1	1		1	0 2/4		1	1	
Ditto for Water	2	6		2	6	each.	2	6	each.
Shivers for Topmaſts	0	11½	per Pound	0	10¾	per Pound.	0	11	per Pound.
For new caſting of Bells ——	0	4½	old Bells.	0	9		0	9 2/2	
For old Braſs	0	6		0	7		0	7½	

Copper.	s.	d.		And in another Contract. s.	d.		s.	d.	
Chimneys ——	1	4¼							
Funnels ——									
Furnaces ——									
Covers for ditto			per Pound						
Hoods —— ——									
Sheet —— ——									
Nails —— ——									
Kettles double ——	1	9							
Old ——	1	2		1	1	per Pound:	1	2	per Pound

Lead.	l.	s.	d.	
Mill'd of 8, 7, or 6 Pound to 1 Foot Square ——	0	19	0	per Hundred Weight.
Of 4 Pound to the Foot —— ——	1	01	0	
Caſt Sheet —— —— ——	0	19	0	
Pipe —— —— —— ——	0	15	0	
Scuppers of 14 Pound to the Foot Square ——	0	18	0	
Hand Leads and deep Sea —— —— ——	0	14	0	
Old and returned —— —— —— ——	0	15	0	
Solder —— —— —— —— ——	0	00	6	per Pound.

Of the Nature and Quality of the COOPER'S CONTRACT.

	l.	s.	d.
FOR Rundlets of ſix Gallons, with ſix Iron Hoops full Bound	0	7	0
Ditto of 12 Gallons, 4 Iron Hoops —— —— ——	0	4	6
Ditto of 8 Gallons, 4 Iron Hoops —— —— ——	0	4	2
Ditto of 6 Gallons, 4 Iron Hoops —— ——	0	4	0
Ditto of 4 Gallons, 4 Iron Hoops —— ——	0	3	4

Nun

	Rate.	Length		Circumference at the Bulge.		Numb of Iron Hoops.	Value.			
		Ft.	*In.*	*Ft.*	*In.*		*l.*	*s.*	*d.*	
Nun Buoys for the 6 ſized Ships.	Firſt	4	8	7	10	12	1	13	0	each
	Second	4	7	7	06	10	1	04	6	
	Third	4	6	7	0	8	1	01	0	
	Fourth	4	0	6	4	8	0	17	0	
	Fifth	3	6	5	4	6	0	13	0	
	Sixth	3	0	4	8	6	0	12	6	

		Depth.	Breadth.		Iron Hoops			
Wood Buckets.			Top	Bottom		*s.*	*d.*	
	Double	9 Inches.	16 Inch.	13 Inch.	6	1	1	each
	Single	7 Inches.	11 Inch.	12 Inch.	6	1	0	each

	s.	*d.*	
Barrels for Tar, and temper'd Stuff, as Pitch, bound with 6 Iron Hoops	8	0	each.
Barrecoes with 4 Iron Hoops 21 Inches long and 10 Inch. over	6	6	each.
Rundlets full Bound of 6 and 4 Gallons	1	8	each.
Rundlets full Bound of 3 and 2 Gallons	1	4	each.
Hoops ſet on Ship's Maſts	0	5½	each.
Wood Spiles	1	0	*per* 1000
Coolers with Rind Hoops 8 Inches deep and 30 Inches over	3	9	each.
Tubs with ſeveral Iron Hoops on each	1	0	each.
Top Hoops	0	2¾	*per* Ft.
Preſs'd Barrel Hoops	0	3½	each.
Smart Hoops	6	0	*per* C.
Rundlets of 12 and 8 Gallons	2	6	each.
Water Tubs of 2 Foot deep and 4 Foot over	12	6	each.
Hogſheads for Roſin, full bound, with 6 Iron Hoops	11	6	each.

The principal Mechanick Power that is ſubject to this Branch is the Wedge, ſince Coopering in the ſtricteſt Senſe is no other than Wedge-work; and the Veſſels being generally made Tapering, are joined together by the Force of Blows on the Hoops. Notwithſtanding the common Tar Barrels are made in a direct Cylinder Figure, and yet obſerved to hold very well, and really if all other Casks could be made in ſuch Shapes, the Stowage would be much to the Advantage of the Owners, and much ſecurer and ſafer for the Ship and Goods.

Sir *William Petty* in his Duplicate Proportion ſays, That a Cask which is to hold a Tun, ought to have 16 times as much Timber in it as a Cask which holds only a Barrel, or the $\frac{1}{8}$ of a Tun.

The Diameters of ſuch Casks are as 2 to 1, and ſo is the Circumference; the Length is alſo as 2 to 1, then the Superficial Area of ſuch Casks will be as 4 to 1, and if every Stave in the great Cask be twice as thick as the Staves in the little Cask, the Timber contain'd in ſuch 2 Casks will be as 8 to 1, that is, the great Cask will have 8 times as much Timber in it as the little Cask.

I ſhall imagine for a clearer Illuſtration of the Work, that the Number of Staves in each Cask be equal, then the large Staves will be of double Breadth and Thickneſs to the ſmall Staves.

OF

ROPE-MAKING.

THE Art of Rope-making or Spinning, is very extenſive, and may be divided into ſeveral curious Heads; as firſt Raiſing and Curing the Hemp, and then Dreſſing of it, then Spinning of it, after Tarring of it, and laſtly, to lay it into Rope of diverſe Sizes, and when worn out to convert it to the moſt ſuitable Advantage, for the Benefit of the Owner; all which Heads would be worthy of Conſideration, ſince the Material is ſo very uſeful for Shipping in general, and upon the good or ill Diſpoſition of the ſame, doth rely the Riſe and Progreſs, or otherwiſe very common Diſaſter, not only to Shipping, but to ſeveral other Mechanical Operations, that is perform'd by the Help and Aſſiſtance of ſuch Materials.

I ſhall not in this Place ſpeak any Thing of the Raiſing and Curing of Hemp, but refer it to thoſe who are thoroughly practiſed in the ſame; but as to the Dreſſing of it, it cannot be done too curious and fine, that the Spinning may be done very nice and even, from a Philoſophical Argument, that was any String ſpun equal and alike in every particular, it would never break, but be infinitely extended without parting. However, it's more generally obſerved, that the evener and exacter Cloth or ſuch Goods are wove, the ſtronger and more ſerviceable it is, and therefore it will not be altogether amiſs to conſider ſomething of Spinning and manageing the Hemp into Yarn.

A Rope-maker for his Day's Task is to ſpin 18 Threads of 170 Fathom long, which is, reckoning the Ground backward and forward that a Rope-maker goes to perform ſuch a Day's Labour, 36720 Feet, or near 7 Miles; and yet it's reported that a good Rope maker will make three ſuch Day's Work in one Summer's Day, which is 20 Miles 4560 Feet. Indeed the other Labour is but ſmall, ſince he only veers out his Hemp as even as he poſſibly can to make a Thread.

There are ſeveral Cautions worthy of Note in this Particular, as to the conſtant and regular Turn of the Wheel, alſo to the Paces of the Workman, that they be made equal and according to the Turn of the Wheel; and that he deliver the Hemp, equally feeding the Thread, neither choaking of it, nor ſtarving of it; but with all the Care that he can poſſibly take to make his Thread even and alike in every Particular; for which reaſon the Wheel ought to be turn'd with ſuch a Device, as to make exact and equal Revolutions in equal Time.

The Artificer ought to meaſure his Pace, by ſuch equal and like Swiftneſs, and deliver his Hemp according to the ſame.

Now whether it be thought reaſonable in the general Opinion, that any common Rope maker is able to ſpin 54 Threads of 170 Fathom long in one Day, or between the Hours of 4 and 9, which deducting but one Hour and a half for Breakfaſt and Dinner, it is but 15 Hours and a half, which is near three Threads and a half in one Hour, and to go over 3107 Feet, or a Mile $\frac{1827}{5280}$ Parts in the ſame time. I ſay, whether it can be thought reaſonable for ſuch an Artificer to do all this Work, and do it well, is the next Thing that ought to be enquired into.

I am poſitive the Threads in Shoe-making are not ſo good as they were ſince I remember, but whether it be through ſuch Lump work, or Badneſs of the Ingredients, I cannot ſay You may alſo obſerve a vaſt Difference in Twine and ſmall Lines, not only in the Hemp, but alſo in the Dreſſing and Spinning of it, which two Parts are very Material, and ought to be perform'd with the greateſt Exactneſs.

In the next Place the Drawing the Yarn through the Tar ought to be well minded, not to make the Tar too hot, that may over heat and burn the Yarn, nor too cold, which may be a Means to over weigh and clog the Yarn with Tar; alſo that the Drawing the Yarn may be with equal Swiftneſs, that one may have as much Allowance as the other, all which ought to be carefully and dexterouſly minded; for which Reaſon there ought to be a Standard for the Weight of Rope of divers Sizes, that the Allowance of Tar ought to be ſo much and no more, according to the Bulk of the Rope, ſince over much Tar may over heat and burn a Rope to pieces, and the leſs Tar there is in any Rope, provided the Thread is juſt covered and preſerved from Wet, the better it muſt needs be for the ſaid Rope.

The Laying of the Yarn, or Twiſting of it into Strands, and after into Rope, and next into Cables or Cablets, is a pretty Device well managed; to obſerve at every laying the Turn of the Wheel is alter'd; as in the firſt Spinning, if the Yarn is ſpun with the Sun, the Strands goes contrary oppoſite to the firſt, and ſo interchangeably altering, till the Rope or Cable, or whatever it be, is finiſhed; which Obſervation puts me in Mind how the Publick Rope may be preſerved from being imbezzel'd, although there has been ſomething conſider'd of this Nature, but to little Purpoſe, ſince I have obſerved that new Rope has been untwiſted, and the Mark Yarn taken out and then the Rope twiſted again, and as well as at firſt; ſo that provided the Rope-maker was to give 20 *s.* per Hundred, for ſuch ſtolen Goods, he would take out the Yarn for the Charge of 2 *s.* per Hundred, and ſell the ſame to Merchant Ships for 40 *s.* per Hundred; ſo that his Gain is 18 *s.* per Hundred, and the Publick loſes 40 *s.* per Hundred; and provided in the publick Service there ſhould be imbezzled but 5 Hundred Weight of Cordage out of every Ship one with another, every Year, the Number is 250 Sail, which will be then 1250 Hundred Weight at 40 *s.* per Hundred, the Sum would be 2500 *l.* a very ſmall Sum conſidering the large Quantity of Cordage there muſt be provided to equip ſuch a large Number of great Ships as 250 Sail, and ſome of them having at leaſt 64 Tuns, and the whole Number muſt have 5996 Tuns, the Value of which is 239840 *l.* at 40 *l.* per Tun.

Now was the Publick Yarn ſpun contrary to that which is provided for Private Ships, there could never be any Embezzlement of that kind; for if there were Neceſſity to ſell the decay'd Rope at Publick Sales, which in all likelihood is ſome Colour for embezzling old Cordage, yet it can be nothing towards a Colour for embezzling of new Rope, neither would any preſume to be concern'd in buying ſuch ſtolen Goods, which would be conſpicuouſly diſtinguiſh'd.

I had not mention'd ſuch ſcandalous Obſervations, had I not ſeen the diſmal Effects by ſuch Faults, ſince ſome Men have been hang'd for the ſame, others impriſon'd; ſome ruin'd by loſing their Employment, and very rare to ſee any enrich'd by the ſame; but the ſpending is commonly according to the getting, and the Perſons only plunged into one Inconveniency or another: I ſhall therefore endeavour to lay down ſome Rules how this may be prevented. Firſt then, the Charge of Cordage to equip the Royal Navy will amount to 239840 Pound, allowing the Price to be 40 *l. per* Tun, or 40 *s. per* Hundred for new Rope, one Size with another, which at preſent, and for Brevity ſake, I ſhall allow of; then for preſerving this valuable Material, and for recruiting of this neceſſary and moſt valuable Branch of the Equipping after the frugalleſt manner that it can poſſibly be done, I ſhall proceed in the following Method.

Firſt I ſhall ſet down the Value of the new Cordage, and alſo what Value has been ſet upon it when it is partly worn.

New

		l.	*s.*	*d.*				*l.*	*s.*	*d.*	
New Cordage at		1	10	0		New at		2	0	0	
When it's worn	1/8	1	6	0	per Hundred. Weight.	When it's worn	1/8	1	15	0	per Hundred Weight.
	1/4	1	2	6			1/4	1	10	0	
	1/3	1	0	0			1/3	1	6	8	
	1/2	0	15	0			1/2	1	0	0	
	2/3	0	10	0			2/3	0	13	4	
	3/4	0	7	6			3/4	0	10	0	
Decay'd Hawſer laid		0	6	0	per Hundred.	Ditto		0	8	0	*per C.*
Junk		0	8	0		Ditto		0	13	8	

The firſt of theſe Tables ſhews the Value of worn Rope, when new Cordarge is for 30 *s.* per Hundred, and the laſt Table ſhews the Value of worn Rope, when new Cordage is for 40 *s.* per Hundred, but the Query is to know when the Cordage is worn to ſuch Degrees as 1/8, 1/2 and the like.

Now whether this Decay in Ropes is reckon'd from the Diameter, Circumference or the Area, I am next to enquire, and in doing of it, I ſhall firſt draw a Parallel between two Ropes, one of 12 Inches 6/10 Circumference, and the other of 6 Inches and 3/10 Circumference.

Inc.		*Inch.*		*Inch.*	
12 6/10	Circumference.	4	Diameter.	12 6/10	The Area.
6 3/10		2		3 3/20	

From which it's plain, that if the Circumference and Diameter be leſſen'd as 2 to 1. the Area will be leſſen'd as 4 to 1.

Now if Ropes were to be carefully uſed, and preſerved from being cut or extream Rubbing, they would laſt a long Time, perhaps ſome 3 or 4 Years, and others would be worſe in a quarter of the Time, and yet the Rope at firſt equal in Goodneſs, ſince it would matter but little though a Rope of 10, 20, 30, or 40 Fathom long had one Defect or 20, that one Defect would as ſoon break him as a far larger Number, provided every Part of a Rope was equally ſtrain'd. Nay, the Rope would be rather ſooner broke with one Defect than a larger Number, ſince the ſtrong Parts would certainly help to break the weak, and therefore a new Rope may as well be ſaid to be 1/3 or 1/4 worn, as an old Rope, provided he has receiv'd any Damage, which is equivalent to a longer Wear.

But if the Defect happen at one End, it may perhaps be ſhifted out of the Strain, or if it will bear ſplicing with Conveniency to the Uſe, the Damage will be but ſmall, only a little ſhorter, and the Labour of the Splice.

But if the damaged Part cannot be ſo ſhifted, it ought to be accounted no other for that Uſe then a Caſt-away; however, ſuch a Rope may be new wrought for a very ſmall Charge, in compariſon of what the Value will be after it is tranſlated. Again, if a Rope is carefully uſed it will, in all likelihood, be very durable, although it may be ſtretch'd, and in ſome meaſure reduc'd of its original Strength, notwithſtanding no Rope ought to be wholly laid by, until it has ſome viſible Defect, ſince you may obſerve how ſeveral private Ships will wear their Rigging, and ſhift it often for the Advantage of its Duration; they will alſo Tar it, and preſerve it from the Weather, and make it look as freſh as if it was juſt new.

The *India* Ships, which are very chargeable in their Equipping, ſcarce make any common Sales, but convert their Rigging from one Species to another; there is no 1/3 or 1/4 worn amongſt their Ships; neither need there be any ſuch Waſte in other Places, was the Management nicely inſpected; but if it muſt be ſo, I ſhall give my Opinion how it ſhould be adjuſted; as for Inſtance.

Provided that a Rope by ſome Diſaſter be cut or rub'd, that the Remains of ſound Yarn ſhould be 1/2 leſs in the Diameter, than it was before it was ſo

rub'd

rubb'd, the Strength would be leſſen'd as 3 to 4, altho' the Damage, in appearance, is but as 1 to 2; or if any Rope, by long wearing, ſhould ſtretch to ſuch a Degree, that the Diameter ſhould be but half of what it was at firſt, then the Strength would be but $\frac{1}{4}$ of what it was at firſt; which Obſervation would lead us to make a true and exact Survey of the Defect in any Rope, and how the Wear in Rigging may be nicely adjuſted: Notwithſtanding ſuch Obſervations ſhould not engage us to ſell the Rope as ſoon as it's a little worn for half the Value, and immediately put more in it's Place to be hurried the ſame way; ſince after it is very much decay'd, it may be taken to Pieces and new wrought to much greater Advantage, as you may perceive in my Obſervation immediately following, which is part of the twice laid Rope-maker's Contract.

I am, ſays the Contract, to make Cablets out of caſt Shrouds, for the Price of 3 *s. per* Hundred Weight, his Majeſty at the ſame time only finding Tar, which if it was to be half an Hundred Weight of Tar to one Hundred Weight of old Rope, the Charge would be but 8 *s.* and then the Rope in all likelihood would be little inferiour to new for the Uſe of Hauſers, that are generally uſed to warp and hale a Ship from one Place to another; however, I ſhall Value it at 30 *s. per* Hundred, and then there would be at leaſt 20 *s.* Gain for the old Rope, allowing 2 *s.* in every Hundred for Waſte.

To make out of Junk Rope (or indeed the worſt ſort of decay'd Rope) Netting, Port-Ropes, Bolt-Ropes, all ſorts of Spun Yarn, for 2 *s.* 2 *d. per* Hundred Weight, and this Obſervation will help to make out my other; ſince here you may plainly ſee, that the very worſt ſort of decay'd Rope may be converted to Netting Rope, which, when new Rope is valued at 30 *s. per* Hundred, Netting Rope is valued at 25 *s. per* Hundred, which is $\frac{5}{6}$ of the Prime Value; and if ſo, it may be very well allowed, that the Produce of ſuch Rope as will make Cablets may be valued at 34 *s. per* Hundred, when new Cordage is valued at 40 *s. per* Hundred.

Again, to make out of caſt Shrouds all Wormings for 3 *s.* 6 *d. per* Hundred; alſo in another Contract, to work up Fag-ends into Cablets, from 8 Inches downwards, at 4 *s. per* Hundred, and Hawſer laid Cordage from 3 Inches and a half downwards for 3 *s. per* Hundred.

Theſe ſeveral Species mentioned (which may be the Produce of old decayed Rigging) would, if rightly apply'd, expend a large Quantity thereof, and be converted very advantagiouſly to the Owner; and after all theſe Converſions, there may be Oakham provided for the ſaid Number of Shipping, out of the very worſt ſort of decayed Rope; which Quantity of Black Oakham yearly expended in the Navy, cannot be leſs than 343 Tuns 6 Hundred; and in allowing of this Quantity of Black Oakham, I approve of filling the Seams that are large with the ſame Species; neither can I ſee much Neceſſity for driving any White Oakham into any Ship, except it be in ſmall Crannies, that will not receive Black, ſince the Price is indeed at Prime Coſt near as 3 to 2; and conſidering the Black will be the Produce of old decay'd Cordage, which lyes often upon Hand, and is ſold for but ſmall Rates, the Price will be in a far larger Proportion: I am ſure Black Oakham is more durable, and a better Preſervative for the Plank than White Oakham, which will be ſooner decaying; and alſo Black Oakham, was it not for ſplitting and ſqualing ſmall Work, would be ſqueez'd into a firmer Thread, and be better Proof againſt Leakage than White Oakham can poſſibly be.

From all which I ſhall ſtate the Caſe thus; that if all the Ships in the Publick Service were to have all new Rigging at one time, and the Quantity would be 5996 Tuns, which at 40 *s. per* Hundred would be 239480 *l.* and that it is allowed that the whole Quantity ſhall be totally decayed into Oakham Stuff in Seven Years; but after ſuch a manner, in ſhifting it gradually and by turns; there ſhould be as much left yearly as would provide Oakham for the whole Number of the ſaid Ships, both for building them, and alſo for every other neceſſary Repair; then * 343 Tuns 6 Hundred by 7, it will be 2403 Tuns 2 Hundred, which is near $\frac{1}{2}$ the Cordage expended in Oakham Stuff, beſides the Wear and Waſte, which in all likelyhood may be $\frac{1}{6}$ more of the whole 5996, that is 999 Tuns added to 2301 Tuns 2 Hundred, is 3402 Tuns 2 Hundred; which ſubſtracted from 5996, there remains 2593 Tuns 18 Hundred; ſo that there will be that Quantity to convert to other Uſes, provided it ſhall be found requiſite, or that the Virtue of well made Rope ſhould totally expire in Seven Years, which I am not apt to believe for the Reaſons as follow.

The firſt Reaſon is, that after ſuch Rope is quite wore out, and converted to Oakham, and drove into the Seams, it will laſt good and preſerve the Ship from Leaking 20 Years, and at the Expiration of that Time be found to be very ſound and good; ſo that it ſeems reaſonable, that the Hemp, when well and properly Tarr'd and twiſted into Rope, may laſt with good Uſage double the Time of Seven Years; and if ſo, all our decay'd Rope may be converted to Uſe for Oakham, and then the Charge of the Cordage and Oakham for all our Royal Navy will be but 17131 *l.* a Year, only allowing $\frac{1}{10}$ of 40 *s.* for making it Oakham, and $\frac{2}{10}$ to make divers and ſuitable Converſions of one ſort of Rope, and by new working to bring it to another ſort; which $\frac{2}{10}$ will be 5150 *l.* which added to 17131 *l.* it is 22281 *l.* a Year, to ſupply all the Publick Ships with every ſort of Hemp Materials that are Tarr'd, and the ſame Sum ſo allotted to be ſufficient and ſuitable to comply with the Wants of ſuch a Material in War Times, when the Number of Shipping is interchangeably out and in, according to the ſeveral Services requiſite, and neceſſary Repairs of the ſame.

The ſecond Reaſon for the Duration of Rigging is, that except it be Shrouds and Stays, and ſome Material Ropes, others may be ſhifted and worn much longer than uſual, as particularly in Sheets and Tacks, where the Rope is ſeldom ſtrain'd till the Sail is near hauled to it's Place; ſo that the looſe End of the ſame is very little worn, when the other muſt of neceſſity be ſhifted; the like is in Braces and Bowlines, which muſt have a double Length for the Conveniency of traverſing the Sails, all which are a large Number conſidered together in ſuch a large Number of Ships.

Then as for ſeveral others that are equally ſtrain'd, they may be ſhifted (when they are well worn, and their Strength reduced) to Places where leſs Strength is required, as the Bowlines having leſs Strain upon them than the Leechlines, tho' belonging to the ſame Sail; and ſeveral other Ropes, if nicely conſidered, may be altered to the Advantage of the Owners, provided they are not viſibly abuſed, but carefully looked after and gradually worn.

For to ſee good Cables cut up, and converted to Oakham Stuff, where the Value is but 8 *s per* Hundred, when at the ſame time the Yarns appear freſh and good, and if nicely inſpected, would make ſuch Rope as would be worth 20 or 30 *s. per* Hundred; ſo that it will plainly appear that half at leaſt is waſted and loſt, and the Oakham little better for the Uſe than if it was made of Sweeping, or the worſt ſort of decayed Rope.

Alſo good Stays, Shrouds, and the largeſt ſort of Caſt Rope, converted to the very worſt and inſignificant Uſes, and the ſmall Stuff (that is every way as fit to be converted to Oakham) ſold for half of the Value.

But perhaps ſome may object againſt the very worſt of old decayed Rope, and ſay it's not fitting for Oakham, and that it may be of dangerous Conſequence, if ſuch Material is drove under Water, that will not be Proof againſt the ſame, and preſerve the Ship from Leakage; but ſuch Objections muſt needs be too weak to defend themſelves, ſince the very worſt Rope that can be, if it's not quite rotten, will be fitting for to make Oakham, provided it be well picked, and all the Hindrance or Diſadvantage that will happen will be in the making of it Oakham, if it be extreamly ſhort, tho' the Oakham Pickers will cut the long Stuff into Foot Lengths, and therefore if the Yarn will hold that Length, it will be according to the required Size.

But however, if it will hold half that Length, or 6 Inches long, it may with good Management be ſufficient to make good Oakham, and then longer Lengths may be preſerved for better Uſes.

I have obſerved, that at Sea the Boatſwains will make good Sinnet to furl the Sails with, and Spun Yarn, alſo Plating out of decay'd Cables, and the like, which Plates will laſt a Voyage, though it be 4 or 5 Years, without repairing, and afterwards with a little Thrumming as much longer, and after that will be fitting for Paper Stuff, ſo that the Publick may have all their Baskets and Brooms in Traffick for the Sweepings of Rope, which is the very worſt of the ſame, and what may be term'd not fitting to make Oakham Stuff.

Which Charge of Brooms and Baskets, I doubt not but will be found a large Article in the cleaning and keeping in due Decency, not only the Shipping but all Store-houſes and uſeful Appartments, which belong to the Publick, in his Majeſty's Yards, which are made uſe of for building and rebuilding of Ships.

That I am really of Opinion the Charge of Cordage may be reduc'd to half what the uſual Charge has been, and the Navy every way as ſafe and ſecure as it ever was, provided the Management be nicely and with Indifferency conſider'd. But I ſhall paſs on to conſider of ſome other Species belonging to Rope-making.

Decay'd Hawſer-laid Rope is valued at 6 *s.* per Hundred, and Junk for 8 *s.* per Hundred; ſo that here is 2 *s.* in every Hundred Difference between Hawſer-laid Rope and Junk.

The Word Junk generally imports a ſort of Ship, but the Term amongſt Mariners is underſtood of a Piece of any Cable cut off to make Oakham of, now if Junk be converted to Oakham Stuff, which is but 14 *s.* per Hundred, when it is Oakham, and at the ſame time ſome Hawſer-laid Rope converted to Laſhing or Netting, which when made is valued at 16 *s.* and 24 *s.* per Hundred, there needs muſt be either ſome grand Miſtake in the Sale of ſuch Goods, or otherwiſe in the Wear of the ſame; and ſo by Conſequence the Degrees of the Wear in ſuch Materials muſt be unequal, and not grounded on a true Principle of Art, or the Judgment in Selling muſt be deficient, and grounded only upon the Fancy of the Managers, and not according to the Goodneſs of the Material.

I ſhall ſuſpend this Diſcourſe, and bring in the Accuſtomary Contracts that are made with the twice laid Rope-makers in the Publick Service, and alſo the Price of the new Cordage with the Prices of all ſorts of Fiſhing Lines, and Hooks, which will be as follows.

Of the Nature and Quality of the Twice-laid ROPE-MAKER's CONTRACT.

TO work up His Majeſty's Ground-Tows, Flyings, and Hemp into Lines, Marlin and Twine, of the Sizes and Weights here-undermentioned, and at the Prices following.

Species, *&c.*		Number of Threads	Leng.	Weight of Doz.	Value.	
			Fathom	*C. q. l.*	*s. d.*	
Lines Deep Sea	Out of Ground Tows and Flyings.	9	85	1 3 20	14 9	per Hundred Weigt.
Lines Cabbin		6	18	0 1 04	14 9	
Lines *Hambrough*		9	18	0 1 04	14 9	
Hammock-Lines of the uſual Length and Sizes						
Marlin	Out of Ground Tows and Flyings	2	32	to one Pound Wt.	14 9	per *lb.*
Mark Twine			140		00 3	
Croſs grain'd						
Yarn ſingle			75		12 0	
Sail Twine fine	Out of good Hemp.	2	360		00 6	per *lb.*
Ordinary Twine and Bolt Rope Twine		2	200		00 5	
Loglines double	Out of Bar Hemp from Twine Hemp.	3	40		05 8	per Dozen.
Ditto ſingle		6	20		02 0	
White Oakham					00 6	per *l.*

And in Conſideration of the abovesaid Prices, the Rope-maker is to find Wheels, Hatchels, and all manner of Tools neceſſary for performing the Work; as alſo Wheel-Turners, and all ſorts of Workmanſhip whatever, at his own proper Coſt and Charges; and his Majeſty is to have no other Charge than to find Hemp, Flyings, Ground-Tows, and Oyl to dreſs the ſame, and all to be perform'd in his Majeſty's Yard.

To make Cablets out of his Majeſty's Caſt Shrouds, the King finding Tar, and his Price is to be 3 *s.* per Hundred Weight.

To make out of old Junk Ropes, Netting, Laſhing, Port-Ropes, Bolt-Ropes, and all ſorts of Spun-Yarn, at the Rate of 2 *s.* 2 *d.* per Hundred.

To make out of Caſt Shrouds all Sorts and Sizes of Wormings, as ſhall be demanded, the King finding Tar, at 3 *s.* 6 *d.* per Hundred.

As alſo to work up his Majeſty's Fag-ends into Cablets, from 8 downwards, at 4 *s.* per Hundred, Hawſer laid Cordage from 3 Inches and a half downwards, at 3 *s.* per Hundred Weight.

Notwithſtanding there are no manner of Stores that continue long at one ſettled Price, for Reaſons I have fully mentioned in ſome other Places, ſince new Cordage at this Time is not ſerv'd in his Majeſty's Stores under 40 *s.* per Hundred Weight, tho' it has formerly been ſerved for the Prices following.

Cordage, 170$\frac{1}{2}$.

		l.	s.	d.	
New		1	10	0	per C. Wt.
Worn	$\frac{1}{8}$	1	06	0	
	$\frac{1}{4}$	1	02	6	
	$\frac{1}{3}$	1	00	0	
	$\frac{1}{2}$	0	15	0	
	$\frac{2}{3}$	0	10	0	
	$\frac{3}{4}$	0	07	6	
Decay'd Hawſer-laid		0	6	0	
Junk		0	08	0	
Laſhing		0	16	0	per Coil.
Netting		1	04	0	
Marlin		0	00	3$\frac{1}{2}$	per *l.*
Lines	Deep Sea	0	06	6	each
	Log	0	00	8	
	White	0	01	2	
Spun Yarn		0	18	0	per C.
Twine		0	00	8	per *l.*

Neceſſaries for the Fiſhing Trade.

		l.	s.	d.	
Hooks	Albecore great	0	02	10	per Dozen.
	Small	0	01	4	
	Dolphin	0	01	6	
	Bonetta	0	01	2	
	Mackerel	0	01	0	
	Bait	0	00	2	
	Shark	0	02	6	
Lines	Albecore great	0	02	2	each.
	Small	0	01	4	
	Dolphin	0	01	4	
	Bonetta	0	01	0	
	Mackarel	0	00	5	
	Bait	0	01	4	perDoz
Fiſgigs		0	03	0	each
Harpen Iron		0	02	2	
Turtle Irons		0	00	10	
Nets		3	15	0	
Sayns		4	05	0	
Twine		0	0	10	per *lb.*

And having ſhewn you what is done by a Congreſs of the ableſt Gentlemen in *England*, I ſhall proceed to make ſome uſeful Obſervations on a Piece that was publiſhed by *John Davis* a Boatſwain, and called the Seaman's *Speculum.*

This *John Davis* to my Knowledge was Boatſwain of ſeveral Ships of War, and by all Circumſtances ſome very good Merchant-ſhips. I do remember that he was counted a very good Boatſwain, according to the Value that is generally put on ſuch Men, and therefore no doubt but that he had experienc'd the Rigging of ſeveral Ships in every reſpect; and having, by a long Experience, obtain'd his Practice, and juſt, (as I may term it) finiſh'd his Courſe, and going out of the World, being arriv'd to a good old Age, not

leſs

leſs than Seventy Years, would never be ſo diſingenuous to publiſh that Piece without it was really the beſt Sentiments he had of ſuch Matters, and therefore I have taken ſome Pains to ſurvey it, and muſt really declare, that there are ſeveral Things worthy of Note; and further preſume to ſay, that no Man need better to be aſſiſted in the Rigging Part or Equipping the Machine, than what he will find in this preſent Piece, my *Ship-Builders Aſſiſtant*, and in the *Seaman's Speculum* afore mentioned; and that he may be better aſſiſted in reading thoſe three Books for the Price of one Pound, than a Practical Rigger may learn him for twice the Sum.

However, for the Good of that *Speculum*, and my Bookſeller, in the Sale, alſo for the Benefit of ſuch as read it, I ſhall explain ſome Places in it, which I obſerve to be ſomething Myſterious.

The firſt Place that I take Notice of, is at Page 34. where he has calculated a Table to ſize the Ropes to the Blocks, which is a Matter highly neceſſary in the Rigging of Ships. The firſt Column towards the Left Hand ſhews you the Circumference of the Rope, and all the other Columns ſhew you the Length of the ſeveral faſhion'd Blocks in Inches. However, I muſt confeſs that this cannot be called abſolutely ſizing of Blocks, ſince the Difference between the Rope and the Shiver-Hole is not mentioned, and therefore I have more particularly ſized the Blocks to the Ropes, as you may obſerve in the Blockmaker's Contract; however, for ſuch as are not over Curious, the Calculations in the *Speculum* will be extream uſeful.

The next is a Table at Page 38. which is ready calculated for ſizing the Anchors or Grapnels to their reſpective Hawſers or Cables, and in this Calculation he agrees nicely with me. He tells you, that for every 20 Tun any Ship meaſures, you may allow 100 Weight for the biggeſt Anchor, which is all one to what I have mentioned in this Piece; and that for every hundred Tun any Ship meaſures, you may allow 5 hundred Weight for the biggeſt Anchor.

Then he ſays, for every hundred Weight the Anchor contains, allow 40 Rope Yarns to compoſe the biggeſt Cable, but with this Caution, that ſuch a Rule will not ſuffice to proportion ſuch Materials for Men of War, intimating, that ſuch Ships are either more expoſed to the Weather, or otherwiſe their Anchors and Cables are of a more general Uſe than the Merchant-ſhips are, and ſo of Conſequence, by their continual Uſe are more rubb'd, and will require a ſuitable Strength agreeable to ſuch extraordinary Rubbing.

The firſt Column ſhews you the Circumference of the Hawſers and Cables in Inches and Parts, and the three other Columns ſhew you the Weight of the Anchors and Grapnels in Hundreds, Quarters and Pounds.

In the 39th Page he proceeds to tell you ſomething of the Nature of Rope-making, which cannot be unneceſſary to any, eſpecially to ſuch as may be in ſome Foreign Countries, where they may be obliged to make their own Cordage, for want of Rope-makers there to make it for them.

He tells you firſt, that 30 Fathom of Rope Yarn will make 20 Fathom of Rope, obſerving that in twiſting the Yarn into Rope, it will ſhorten 10 Fathom or $\frac{1}{3}$, and that is for Hawſer-laid Rope; however, I ſhall Mechanically ſhew how this Faculty ought to be conſider'd.

He tells you, that Hawſer laid Rope (which is Rope that is double laid) will be as big when its made, as it is in the Yarn, ſo that what leſſening is made by hardening, is ſwell'd by ſhortening, ſince, he ſays, that for every 20 Fathom of 4 ſtran'd Rope, you muſt allow 31 Fathom of Yarn, after it's ſtretch'd well and made tight, but Tout he calls it.

At Page 40. he ſhews you what Number of Fathoms and Feet of Rope-Yarn will make Fathoms and Feet of Stays, or Buoy-Ropes; where in the firſt Article for the Stays he tells you, that 10 Fathom and 3 Feet of Yarn will make 1 Fathom and 3 Foot of a Stay, which Tables I hold to be very uſeful, if they were well underſtood.

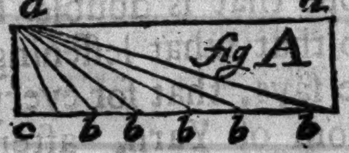
At Page 41. he has calculated a Table to ſhew the Number of Fathoms and Feet of Yarn, which make a certain Number of Fathoms and Feet of Hawſer-laid Cordage; in the firſt Article, I obſerve that 9 Foot of Yarn will make 6 Foot of Rope, which is as 3 to 2, ſo that the hardening and ſhortening is allowed aſter that manner as 3 to 2, to ſhorten 1 Foot in every 3 Foot, and this Table holds ſuch a Proportion throughout as 3 to 2.

The Table in Page 42. ſhews the Proportion of Cable-laid Rope. The 2 firſt Columns towards the Left Hand ſhew you the Number of Fathoms and Feet of Yarn that will make Fathoms of Cable laid Rope, which is ſet down in the third Column. The firſt Article ſhews, that 10 Foot of Yarn will make 6 Foot of Cable-laid Rope, which Proportion is as 5 to 3; ſo that this Table allows of ſhortning 2 Foot in every 5 Foot, and this Table holds ſuch a Proportion throughout as 5 to 3, of which I ſhall more particularly conſider hereafter. He has ſet down the Quantity of Canvas, and the Nature of the Sail Cloth, to make three Suits of Sails; one Suit for a Ship of 521 Tuns called the *Bonadventure*, another Suit for the *Vanguard* of 1442 Tuns, and another Suit for the *Royal Sovereign* of near 1800 Tuns. The Length of the *Bonadventure* from the Stern to the fore Part of the Lyon at the Upper Deck, is very probable to be 135 Feet; then multiplying ſuch a Length into itſelf, or ſquaring it, it will be 2025 Square Yards, which is the Area I deem ſufficient for Sail Cloth to make ſuch a Ship a Suit of Sails. The Canvas I find in the *Speculum* that ſuch a Suit of Sails contain, is 2358 Yards of Cloth 2 Foot broad; but this is but $\frac{2}{3}$ of Square Cloth, which will then be 1572 Yards; ſo that there will be 453 Yards leſs than what I allow ſuitable to make ſuch a Suit of Sails, according to my former Obſervation.

The Length of the *Vanguard* the ſame way I deem to be 180 Feet, then multiplying that Sum into itſelf, it is 3600 Yards Square, which is the Superficial Area I deem ſufficient to make Sails for ſuch a Ship; but the Canvas I find in the *Speculum* is 5838 Yards of 2 Foot broad, ſo that $\frac{2}{3}$ of 5838 is 3892 Square Yards, and that is 292 Yards more than what my former Obſervation allows of.

The Length of the *Royal Sovereign* by the ſame Rule, is very probable to be 193 Foot; then ſquaring that Number it is 4196 Yards, which is the Number of Yards Square I deem ſufficient to make a Suit of Sails for ſuch a Ship; but the Canvas I find in the *Speculum* converted to make her Sails, is 5838 Yards of 2 Foot broad, which will be 3962 Yards Square; ſo that the Difference is 174 Yards, and therefore this Ship, according to the Calculation, has ſuch a Quantity of Canvas leſs in her Sails, than what I deem ſufficient, according to my former Obſervations.

From all which it may plainly appear, that there is no exact Rule for this Equipping, ſince one Ship is ſome Hundred Yards over my ſet Allowance, and the other as many Yards under it; and why ſuch Variety ſhould be, and yet the Buſineſs managed by the ſame Hands, I profeſs is a Paradox to me; but ſuſpending the Subject in this Place, I ſhall proceed to the Rope-making again, in which I ſhall firſt inſtance ſomething of my own Obſervation on that Particular.



I ſhall for our better Imitation of this Matter, deſcribe the Nature and Parts of a Rope, allowing of it in ſome Meaſure to be like a Screw, for indeed it is twiſted Work; ſo that in the Figure A. I put *a. d.* to ſhew the Length of a Rope, and ſhall call the Length of a Rope the Baſis; then the Line *a. c.* being the Diameter, I ſhall call it the Perpendicular of the Cable, and the Lines *a. b.* being drawn at ſome certain Angles, ſhewing the Obliquity of the Strands in a Cable, I ſhall call them the Hypothenuſe, and ſo by Conſequence deſcribe, or bring this Faculty in ſome Meaſure to the Doctrine of Triangles. In Screw Work ſuch Slope Lines are called the Helices, or a Gut, that being wreathed about a Cylinder, cauſes (if I may ſay ſo) Hills and Dales; ſo the Ropes are Strands winding about each other, as a Gut or Helices, according to the Number of Strands that there is in any Rope.

Helicoſophie (from *Helix* a Spiral Line, and *Sophia*, Wiſdom, Craft or Skill) is an Art Mathematical, which demonſtrates the deſigning of all Spiral Lines in Plano, on Cylinder, Cone, Sphere, Conoid, and Spheroid, and their Properties appertaining, the Uſe whereof in Architecture, and divers Inſtruments and Engines is moſt neceſſary; for in many things the Screw worketh the Feat, which elſe would not be performed.

But *Helix* being a *Greek* Word, ſignifies a winding Spiral Figure, or a crooked Line, which is unequally diſtant from the midſt of the Space, howſoever incloſed.

From all which I will allow, that the Word *Helix* muſt be the Signification of ſuch winding Parts as are in Screw Work, ſince the Curves that are made by cutting a Cylinder at any oblique Angle, will be Eliptick Figures, and not true Circles that can be made by the common Compaſſes, which will alſo be in the Strands of Cables, and therefore I ſhall more fully illuſtrate the Parts of any Rope that are equally aſſiſting to the Strain; but firſt I ſhall ſhew the Proportion that the Circumference and Diameter of a Rope has to the Twiſting of the Strands in a whole Circumference.

	Inches.
The Circumference of a Cablet Rope being	$14\frac{1}{4}$
The Length of the Strand in one Circumference is	$19\frac{7}{8}$
The Circumference of a Cablet Rope being	12
The Length of the Strand in one Circumference is	16
The Circumference of a Hawſer-laid Rope is	$7\frac{1}{8}$
The Length of the Strand accordingly is	$9\frac{1}{2}$
The Circumference of another was	$2\frac{1}{2}$
The Length of the Strand was	$3\frac{3}{8}$

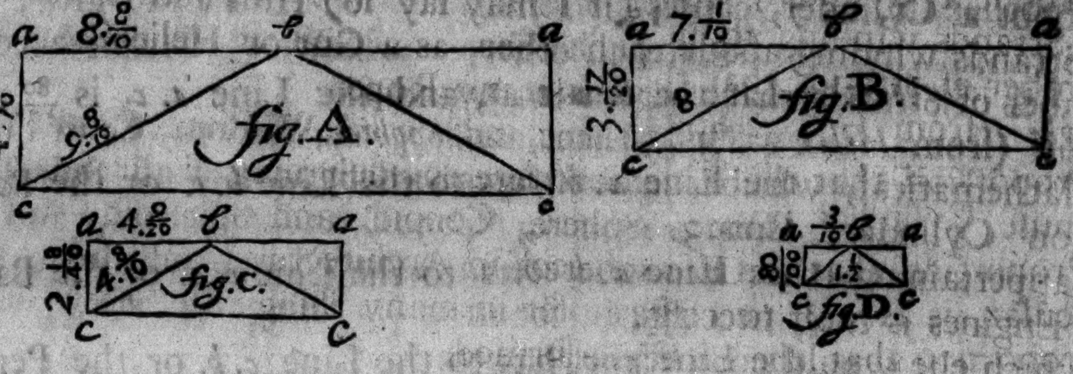
Then the Proportion of the Circumference to the Length of the Strands in one Round is	The biggeſt Cablet Rope is as	11 to 15
	The leaſt Cablet Rope is as	11 to 15
	And both the Hawſer-laid Ropes are as	12 to 16

		Inch.
The Diameters are	The biggeſt Cables are	$4\frac{6}{15}$
	The leaſt Cables are	$3\frac{17}{20}$
	The biggeſt Rope is	$2\frac{11}{40}$
	The leaſt Rope is	$0\frac{80}{100}$

The $\frac{2}{3}$ of the Circumference is	In the firſt Size it is	$9\frac{1}{2}$
	In the ſecond Size it is	8
	In the third Size it is	$4\frac{3}{4}$
	In the fourth Size it is	$1\frac{68}{100}$

And now I proceed to lay down ſome Figures of the Ropes of the ſeveral Sizes, and make ſome Mechanical Demonſtrations from the ſame.

In



In the Figures you may obſerve, that the Diagonal Lines *b. c. c.* ſhew the Length of the Strands of Cables or Ropes, and the Lines *a. a. c. c.* ſhew the Progreſſive Length of the Ropes made by ſuch a Length of Strands, and the Lines *a. c.* ſhew the extream Diameter of the Ropes.

The Progreſſive Length in the Figure A. in one Round about made by the Strand, is $17\frac{6}{10}$.

The Progreſſive Length in the Figure B. in one Round about made by the Strand, is $14\frac{2}{10}$.

The Progreſſive Length in the Figure C. in one Round about made by the Strand, is $8\frac{18}{20}$

The Progreſſive Length in the Figure D. in one Round about made by the Strand, is $2\frac{6}{10}$.

Then the Length of the Strand, to the Progreſſive Length in the Figure A. is as $19\frac{6}{10}$. is to $17\frac{6}{10}$.

And the Length of the Strand, to the Progreſſive Length in the Figure B. is as 16 is to $14\frac{2}{10}$.

And the Length of the Strand, to the Progreſſive Length in the Figure C. is as $9\frac{6}{10}$ is to $8\frac{16}{20}$.

And the Length of the Strand, to the Progreſſive Length in the Figure D. is as 3 is to $2\frac{6}{10}$.

Inches.
In the Figure A. the Line *a. b.* or what I call the Baſe is ——— $8\frac{8}{10}$
The Line *a. c.* or the Perpendicular is ——— ——— $4\frac{6}{10}$
And the Line *a. b.* or the Hypothenuſe is ——— ——— ——— $9\frac{8}{10}$

Now in Geometry every whole is equal to its Parts, ſo that the Lines *a. b.* will bear the ſame Proportion to the two Diagonal Lines in that Figure.

The Proportion that the Baſe in this Figure has to the Perpendicular is as 19 to 10.

The Proportion that the Baſe has to the Hypothenuſe in this Figure is as 9 to 10.

The Proportion that the Perpendicular has to the Hypothenuſe is as 7 to 15.

In the Figure B. the Line *a. b.* is $7\frac{1}{10}$, and the Line *a. c.* is $3\frac{17}{20}$. and the Line *c. b.* 8.

The Proportion that the Line *a. b.* has to the Line *a. c.* or the Baſe to the Perpendicular, is as $14\frac{2}{10}$ to $7\frac{14}{20}$.

The Proportion that the Line *a. c.* has to the Line *c. b.* or the Perpendicular to the Hypothenuſe, is as $7\frac{14}{20}$ to 16.

In the Figure C. the Line *a. b.* is $4\frac{9}{20}$, and the Line *a. c.* is $2\frac{18}{40}$, and the Line *c. b.* $4\frac{8}{10}$.

The Proportion that the Line *a. b.* has to the Line *a. c.* or the Baſe to the Perpendicular, is as $4\frac{9}{20}$ 2 to $\frac{18}{20}$.

The Proportion that the Line *a. b.* has to the Line *c. b.* or the Baſe to the Hypothenuſe, as $4\frac{9}{20}$ to $9\frac{6}{10}$.

The

The Proportion that the Line *a. c.* has to the Line *c. b.* or the Perpendicular to the Hypothenuſe, as $7\frac{1}{10}$ to 15.

In the Figure D. the Line *a. b.* is $1\frac{3}{10}$, and the Line *a. c.* is $\frac{80}{100}$, and the Line *c. b.* it $1\frac{5}{10}$.

The Proportion that the Line *a. b.* has to the Line *b. c.* or the Baſe to the Hypothenuſe, is as $2\frac{6}{10}$ is to 3.

The Proportion that the Line *a. b* has to the Line *c. a.* or the Baſe to the Perpendicular, is as $1\frac{3}{10}$ to $1\frac{60}{100}$.

The Proportion that the Line *a c.* has to the Line *c. b.* or the Perpendicular to the Hypothenuſe, as $\frac{80}{100}$ to $1\frac{5}{10}$.

The three firſt Particulars or Figures, ſeem to correſpond ſo near, that I ſhall rather condemn my own Care in taking the Dimenſions, than the Ropemakers Gauge in Twiſting his Rope, and therefore I ſhall allow that the Angles made by the Twiſting of moſt Ropes upon a direct Plan, will be according to ſuch Dimenſions, and that the Relative Length of the Strand to the Abſolute Length, is as 9 to 10; the Abſolute Length I allow to be what the Strand would be if it was untwiſted, and ſtretch'd on the Hooks in order to Twiſt into a Rope, and the Relative Length of the Strand is the Length that ſuch a Strand makes the Rope when it is laid and perfected.

Mr. *Davis* in his *Speculum* ſays, that in all Hawſer laid Rope, the Yarn ſhortens in working the Rope $\frac{2}{3}$, and this he allows after ſuch a manner as he mentions that a Yarn of 30 Fathom Length will make a Rope of 20 Fathom long, and this Proportion he mentions without any Exception to the Diameter of the Rope: He ſays, this ſhortning will be thus, that the Yarn will harden in 6 Fathom, or $\frac{1}{6}$ of the Length, and will ſhorten in the laying 4 Fathom, or near $\frac{1}{8}$.

The Hardening I take to be in the Yarn, ſince at the firſt Spinning the Yarn is little better than Hemp, extended to ſome certain Length, and ſo it continues until it is laid into Strands, and then by the Twiſting the Yarn hardens, by which Hardening it ſhortens to ſome Degree, according to the Judgment of the Rope-makers; but this is not the abſolute Hardening or ſhortning of the Yarn, ſince the Strand will alſo harden and ſhorten in the laying into Rope, as well as the Yarn, by being laid into Strands; but however, all this Hardening and Shortning muſt be reckoned out of the Yarn, tho' it will happen in every Viciſſitude of the Work.

The Coming in, as he terms it, muſt be meant of the ſhortning in the laying, cauſed by the Yarn, and the Strands Twiſting and Winding one about another.

Now the Strength in Ropes muſt of Neceſſity be cauſed by this Hardening and Shortning of the Rope, by Twiſting and Cloſing one Yarn or Strand with the other, and not by the bare Strength of the Hemp: But to know the Proportion of this Strength exactly, and which way it is communicated, will require abundance of nice Tryals, as well as ſundry Conſiderations; however, I will firſt ſhew you how the Proportion of Strength in Ropes bears one to another, according to the various Sizes, and then I will endeavour to explain how the Strength is farther increaſed by the Faſhion of the Work; in doing of which I ſhall firſt ſet down the Sizes of Cables and Ropes from 22 Inches Circumference to 1 Inch Circumference, both as to the Circumference, Diameter, and the Area, preſuming that as the Area's are one to another, ſo is the Strength in any Cable or Rope.

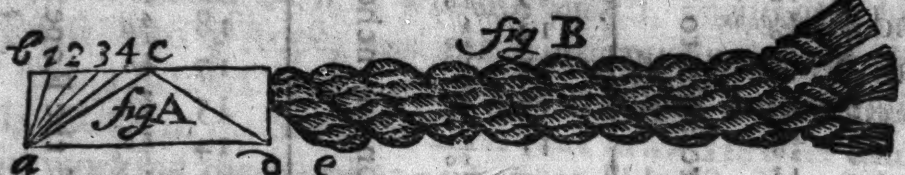
The Circumference of Ropes in Inches and Parts. *Inches.*	The Diameter of each Rope agreeable to the Circumference. *Inches.*	The Area of the Rope at a Croſs Section in Inches and Parts of an Inch. *Inches.*	The Square of the Diameter of the Rope in Inches and Parts. *Inches.*
22	7	38 ½	49
21 ½	6 9/10	37	47 ½
21	6 7/10	35	45
20 ½	6 11/20	33 ¾	43
20	6 4/10	32 ¼	41
19 ½	6 ¼	30 ¾	39
19	6 1/10	29	36 ½
18 ½	5 9/10	27 ¼	35
18	5 ¾	25 ¾	33
17 ½	5 6/10	24 ½	31 ¼
17	5 4/10	23	29
16 ½	5 ¼	21 ¾	27 ½
16	5 1/10	20 ½	26
15 ½	4 19/20	19 2/10	24 ½
15	4 ¾	17 8/10	22 ½
14 ½	4 6/10	16 7/10	21
14	4 9/10	15 6/10	19 8/10
13 ½	4 2/10	14 5/10	18 6/10
13	4 1/10	13 ½	17 3/10
12 ½	3 39/40	12 4/10	15 9/10
12	3 17/20	11 6/10	14 8/10
11 ½	3 13/20	10 7/10	13 3/10
11	3 ½	9 6/10	12 2/10
10 ½	3 7/20	8 8/10	11 9/10
10	3 7/40	8	10 1/10
9 ½	3 1/40	7 2/10	9 2/10
9	2 35/40	6 6/10	8 2/10
8 ½	2 7/10	5 8/10	7 3/10
8	2 11/20	5 1/10	6 ½
7 ½	2 4/10	4 ½	5 ¾
7	2 9/40	3 19/20	4 9/10
6 ½	2 3/40	3 13/20	4 1/10
6	1 92/100	2 9/10	3 3/10
5 ½	1 ¾	2 4/10	3 1/20
5	1 6/10	2	2 11/20
4 ½	1 44/100	1 2/10	2 3/40
4	1 28/100	1 28/100	1 64/100
3 ½	1 12/100	0 98/100	1 27/100
3	0 95/100	0 71/100	0 90/100
2 ½	0 80/100	0 50/100	0 64/100
2	0 64/100	0 32/100	0 41/100
1 ½	0 47/100	0 17/1000	0 22/100
1	0 32/100	0 80/1000	0 102/1000

You may obſerve, that where the Diameter and Circumference are as 2 to 1, that is, where the Ropes are one twice as big as the other, the ſuperficial Area made by the End of the Rope, or otherwiſe the Square of the Diameter is as 4 to 1; which ſhews, that one Rope has juſt 4 times as much Yarn in it as the other, and conſequently is 4 times as ſtrong, according to their different Magnitudes.

Now this being the Strength which may be expected through the Difference there is in the Diameter of the Rope, and Number of Yarns, preſuming that 4 Rope-Yarns will be 4 times as ſtrong as 1 Rope-Yarn, provided the Hemp be equally good, and as well performed; and therefore this Strength I ſhall allow to be cauſed from the Quantity of Hemp, and Bulk of the Rope, and may be term'd the Abſolute Strength; and ſo I ſhall proceed to conſider how this Strength in Ropes is farther augmented by the Faſhion or Shape of the ſame.

I have obſerved to you, that all Hawſer-laid Rope ſhortens in making $\frac{1}{3}$, ſo that 30 Fathoms of Yarn will make but 20 Fathoms of Rope; but in Cable-laid Rope the Shortning will be as 5 to 3; ſo that in every 2 Foot of Hawſer-laid Rope, there will be 4 Foot $\frac{1}{2}$ of Yarn, and the Strength will moſt certainly be accordingly; that is, the Strength will be in this Yarn after it is laid in Rope, as much as if the Rope-maker in Spinning had allowed the Quantity of Hemp in 2 Foot Length as he did in 3 Foot Length, ſo that the Strength communicated in this Faculty is $\frac{1}{3}$.

You may farther obſerve, that any Rope is as big when it is laid and in a Rope, as the Yarns are before they are hard twiſted; ſo that what the Yarns are leſſen'd by twiſting hard, is made up by ſhortning and coming in; from which it is very probable, that the Yarns are always of an equal Bigneſs, ſince indeed the Hemp is the ſame at one time as it is at another, and not any ways diminiſhed.



But to conſider this Strength in Ropes, cauſed by the Shape and Figure more particularly; in which I will firſt lay down a Figure, to demonſtrate the ſame as the Figure A. *a. b.* being the Diameter of the Rope, and *a c.* the Angle which the Strand makes in laying; *a. d.* is the Progreſſive Length that the Strand makes by one Circumference, and *a. c.* is the Length of the Strand in one Round. Now if the Strands were only Single, without being wove or twiſted one about another, the Strength would then be only in Proportion as the Area of each Particular Strand is in itſelf; but on the other hand, if the Strands could poſſibly be twiſted after ſuch a manner, that they would be directly Perpendicular to the Baſis, as the Line *b. a.* then the Strength would be found by multiplying the Diameter of the Strand and Diameter of the whole Rope one into another, and the Moity of that would be the Strength of the ſaid Strands; but more particularly to take the Area of the Single Strand, and Area of the whole Cable, and add them together, the half of that ſhall ſhew you the Strength of each Strand, when they are well twiſted together.

But as you may obſerve the Strands lye at a certain Angle, between a Perpendicular and the Baſe, as the Line *a. c.* ſo that as the Angle of Incidence is to Radius, ſo is the Relative Strength to the Abſolute Strength.

The Nature of the SAIL-MAKER's CONTRACT, as Cuſtom.

FIrſt to find at his own proper Coſt and Charge, all Bolt-Rope Lines, Twine and other Materials neceſſary for the Work, excepting Canvas. Secondly, that all the Sails, which are made of *Hollands* Duck, Great Noyles, *Suffolk*, and other Canvas of the like Quality, ſhall be ſewed with a double flat Seam.

And ſuch Sails as are made of Pertrees, Vittroy, ſmall Noyles, *Ipſwich*, and other ſuch ſmall Canvas, ſhall be ſewed with a round Seam, and worked with the beſt *Engliſh* Twine, and alſo that the Number of Stitches following ſhall be in every Yard of Work, *viz.*

In double *Ipſwich*, or great Noyles Courſes		108	Stitches in every Yard of Work, and not under.
Duck, Noyles and *Suffolk* Courſes, Topſails, Spritſails and Mizons	In Duck	100	
	In *Suffolk* & Noils	90	
Vittroy, Pertrees or ſmall Noiles wrought into any ſort of ſmall Sails, and ſewed with a ſingle round Seam		90	

All the Bolt Ropes to be croſs ſtitch'd at every 12 Inches in Length with 3 croſs Stitches, and the ſaid Rope to be of the Dimenſions or Size as follows in the Table, *viz.*

Names of the Sails.		First Rate	Second Rate	Third Rate	Fourth Rate	Fifth Rate	Sixth Rate
		Inch.	*Inch*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
Main	Courſes	6	$5\frac{1}{2}$	5	$4\frac{1}{2}$	4	$3\frac{1}{2}$
Fore	Courſes	$5\frac{1}{2}$	5	$4\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{1}{1}$	3
Main	Topſails	$5\frac{1}{4}$	5	$4\frac{3}{4}$	4	$3\frac{1}{4}$	$2\frac{3}{4}$
Fore	Topſails						
Mizon	Courſes	5	$4\frac{3}{4}$	4	$3\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{2}$
Spritſail	Courſes						
Main Stay-ſail		$3\frac{1}{4}$	3	3	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{4}$

Thirdly, the Bolt-Ropes for all other Sails which are not herein mentioned, ſhall be of the Sizes fitting and ſufficient for the ſame.

Fourthly, two Reeves to be made in every Top-ſail from the Firſt Rate downwards, and one Reeve in every Courſe for Ships of the fourth and fifth Rates, and two in the Courſes for the ſixth Rates, with one Bonnet for each if required.

Fifthly, that all Sails which ſhall be made of Pertrees and Vittroy, and ſuch like Canvas, ſhall have a round Seam in the middle of each Cloth. Likewiſe to make Reeves in the third Rate Courſes, if required; as alſo to make Marlin Holes in all the Sails, if Occaſion require, for the Rope to be ſewed. To worm all Clews, and alſo to make all Holes, and ſtick in all Crinkles, and every Conveniency that is reaſonably required.

He is to be allowed for meaſuring Canvas into his Majeſty's Stores, from the Merchant, 2 *s.* 6 *d.* per Day, and to be allowed for flat ſeam'd Sails 3*d.* $\frac{1}{4}$ per Yard for Sewing, and for every Yard of round Seam, he is to be allowed 2 *d* $\frac{3}{4}$ per Yard.

An ACCOUNT of the Value of ſome other Contingent Materials, which are generally called Wooden Ware.

	l.	*s.*	*d.*	
Ballaſt Basket	0	0	5	each.
Capſtand Bars	0	0	5	per Foot.
Ditto Port	0	0	8	each.
Inches.				
Board $1\frac{1}{4}$ Elm	0	13	0	per hundred Foot
Board 1 Elm	0	11	0	
Board $1\frac{1}{4}$ Fir	0	17	0	
Board 1 Fir	0	14	0	
Buckets Double	0	01	2	each.
Buckets Single	0	01	0	
Buckets Coolers	0	03	9	
Tables Deal	0	06	6	
Tables *Spaniſh* Wainſcot	0	13	0	
Elm Wedges	0	00	1	
Wrain-ſtaves	0	0	10	
Bavins Broom Length 38 Inches, Circumf. 38 Inch.	0	05	0	per Hundred.
Bavins Fuzz Length 44 Inches, Circumf. 44 Inches	0	07	6	
Bavins Bruſh Length 36 Inches	0	13	6	
Spruce Deals of 4, 3, $2\frac{1}{2}$, 2 Inches thick, from 3 *l.* to 5 *l.* per Load.				
Ordininary Deals	0	01	0	each.

Trenels of				*l.*	*s.*	*d.*		*Inch.*	
36	Inches long.	$1333\frac{1}{3}$	In a Load	12	0	0	per 1000	2	Diameter
30		1600		7	5	0		$1\frac{8}{10}$	
24		2000		4	5	0		$1\frac{6}{10}$	
18		$2666\frac{2}{3}$		2	2	6		$1\frac{4}{10}$	
12		4000		1	0	0		$1\frac{2}{10}$	

	l.	*s.*	*d.*	
Long Boats	0	17	0	per Foot.
Pinnaces	0	13	0	
Skiffs	0	12	0	
Handſpokes Birch 7 Ft. and a half long	0	00	9	each.
Handſpokes Aſh 7 Ft. and a half long	0	01	0	
Scoops	0	01	0	
Brooms	0	01	0	perDozen
Oak Laths $\frac{2}{3}$ being Spine and $\frac{1}{3}$ Sap	0	16	0	per 1000
Wainſcots of 12 Foot and a half long	1	00	0	per 100
Holly Wood 1 *s.* per Hundred Weight				

Other Materials.

		l.	*s.*	*d.*	
Pitch		1	18	3	per Barrel
Tar		1	04	6	
Blacking		0	00	3	
Thrums		0	00	8	per Pound
Black Links		0	04	0	per Dozen
Candles of good hard Tallow		0	0	6	per Pound
Brimſtone		0	0	3	per Pound
Roſin		0	0	3	
Tallow hard and White		48	0	0	per Tun.
Train Oyl		25	0	0	
Oakham	Black	0	14	0	per *C.* wt.
	White	0	18	0	
Reed		0	01	6	100 Bolts.
Soap		1	05	0	Firkin.
Hair	Looſe	0	12	0	per *C.* wt.
	Spun	1	10	0	

Materials relating to the BRICKLAYER and MASON.

		ls.	*s.*	*d.*	
Bricks Kiln-burnt		0	18	0	per 1000
Ditto for Paving		0	06	0	Ditto
Tiles	Plain	0	01	4	per Doz.
	Slat	0	13	0	per 1000
	Ridge	0	03	0	per Dozen
Lime 40 Buſhels to the Load		1	00	0	per Load
Sand		0	00	2	per Buſhel
Stones	Healing	0	12	0	per Tun Weight.
	Walling	0	02	8	
	Gutter	0	08	0	
	Pewing	0	00	3	per Foot.
	Smooth	0	00	3	
	Portland	0	14	3	per Tun.
	Pebble	0	04	6	
	For Paving with Stone and Workmanſhip	0	01	0	Yd. Squar
	Rubble	0	01	9	per Tun.
	Aſhler	0	00	7	per Foot.
	Grindſtone	0	01	6	per Foot.
	Rubſtone	0	02	0	each.

Materials

Materials relating to the LEATHER-BUCKET-MAN'S CONTRACT.

	Size.	Length.	Breadth. at great End.	Breadth. at little End.	Value: s	Value: d.	
		Inches.	*Inches.*	*Inches.*	*s*	*d.*	
Leather Liquor'd	—	— —	—	— —	0	10½	perPound
Leather Scuppers for the	First	28	16	6	3	3	each.
	Second	27	16	6	3	1½	
	Third	24	14	4½	2	10	
	Fourth	21	12	4½	2	6	
Leather Buckets		10	9	6½	3	9	

Leather Hoses ſingle ſew'd 6 Inches broad at the great End, and 3 and a half at the ſmall End, having 26 Stitches in every Foot of Length — — —	02	3	perPound
Glew — — — — —	00	5	

FINIS.

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AN INDEX,

Explaining the TERMS us'd in this TREATISE.

Midſhip-flat, is the Floor-timber in the middle or greateſt Part of the Ship, or what properly divides the Ship into two Halves.

Rake of the Poſt, what he declines from a Perpendicular.

Draught of Water, how many Foot and Inches any Ship is below the Surface of the Water.

Rake of the Stem, what projects forward from the ſtraight Line of the Keel.

Stem, the fore-moſt Part of the Ship, as *Stern-poſt* is the after-moſt, or hindermoſt Part of the Ship, that is fix'd intire to the Body.

Rabbit, a Gutter, or Channel in the Keel, Stem, and Stern-poſt, to receive, or fit in the out ſide Plank.

Moulded, the Mark that is made on every Rib, or Timber, to faſhion the Body of the Ship.

Thick-ſtuff, Timber cut into Plank, thicker than four Inches.

Limber-boards, Planks fitted looſe on each ſide the Kelſon, in order to take up and put down, to clear the *Limber-holes*, which are Holes cut in the Floor-timbers; as *Channels* to let the Water in the Ship come to the Pumps.

Floor timbers, the Timbers of the firſt Floor in the Ship, or Seat of bearing.

Floor-line, the Line that ſhapes the Floor-timber.

Breadth-line, the Line, or Mark, that ſhapes the Ship at the breadth.

Riſing-line, a Line that gives the liping or riſing of the Floor-timbers.

Sheering-line, ſhews the ſhape of the Ship at the Wales and Channel-wales.

Scantling, the bigneſs or meaſure of the Parts.

Decks, the Floors, or Plans, the Guns are plac'd upon; whereof there's firſt the Lower gun-deck, the Second-deck, and the Upper-deck, and Quarter-deck, Forecaſtle and Poop.

Poop-lanthorns, ſuch as are plac'd at the aft-part of the Ship, to carry the Candles as Lights.

Bowſprit, a Maſt ſtanding out of the forpart, or Bow of the Ship, at ſome certain Angle, neither Level or Perpendicular.

Top-gallant-maſt, ſuch as ſtands on the Top-maſts; as a Dreſs beyond the Top-maſts.

Cheeks, Oak-pieces of Timber brought on of each ſide a Fir-maſt, to ſave the ſame, and prevent the rubing or twiſting.

Cap, a Piece of Elm put upon the Head of a Maſt, to receive the Top-maſt, *&c.*

Croſs-trees, and *Treſle trees*, are alſo Pieces of Oak brought on upon the Head of a Maſt, to ſecure the Top-maſts, and Top-gallant-maſts.

Partners of the Maſts, are almoſt in the ſame ſenſe to joyn, and to help hold up the ſame.

Running-ſhips, a Term for ſuch Ships as are counted the lighteſt, and ſwifteſt of the Ships.

Main-ſail, the greateſt Sail that belongs to the bigeſt Maſt; as all Maſts gives Names to its reſpective Sail.

Reeves, Holes made at the Heads of the Sails, to take them up, and leſſen them when it over blows, or blows to hard.

Horn, is meant to lay the Beams exactly thwart the Ship, or of the Stern, to be exactly croſs the Keel.

Gratings, are in the Nature of Lattice-windows.

Rails, imboſs'd Pieces, to mark out the faſhioning, or ſheer of the Ship.

Fiſe-rail, the upper or ſmalleſt Rail.

Standing-rigging, ſuch as is fix'd, or immoveable; as *Running-rigging*, ſuch as is for managing, and traverſing the Sails, and other uſes of the Ship.

Planking, to cover the Timber with Plank.

Clamps, thick Planks laying under the Beams of each Deck, to let the Beams into, or to help ſtrengthen the Ship.

Strings, Planks thicker than thoſe joyning to them; and are ſcor'd, to let the Timbers into them for ſtrengthning.

By-hand, in the Seamen or Shipwrights Phraſe, is meant one Man; as if I ſay, I can do ſuch a piece of Work with ten Hands; that is, I can do it with ten Men.

Publick-ſhips, ſuch as are belonging to the Royal Navy; and *Private-ſhips*, ſuch as are for Traffick, or Merchandiſing.

Docking a Ship, to put her into a Dock, in order to repair her.

Sheathing a Ship, to cover the bottom under Water with Board, Tar and Hair, to preſerve her from the Worms.

Chock, a Piece brought on to help the Wants in the growth of Ship-timber.

Triming, dreſſing, or nicely fitting the Work of any kind, in building the Ship.

Frame-timbers, ſuch as are nicely fitted, and put up firſt, to guide the reſt of the Body.

Croſs-pillars, pieces of Timber put croſs, under the Beams of the *Lower-deck*, to ſupport, in caſe the Ship comes to lay on the Ground.

Dubing, a Term made uſe of for working with the Adze, as *Hewing* is for working with an Axe.

Ship's-crew, the whole Company of Men in a Ship.

Tranſums, pieces of Timber that frames the Stern, lays a-thwart.

Calkers, ſuch as drive in Oakam into the Seems, or Chinks of the Planks, to keep the Water out of the Ship.

Oakam, old Ropes untwiſted again; and may be alſo call'd, old tar'd Hemp.

Planks, Timber parted by long Saws, and thoſe that cut them, are call'd Sawyers.

Block-makers, ſuch as make the Pullies for the Ropes to be hal'd through.

Plaiſterers, ſuch as covers the Planks in the Wake of the Fire-place, to ſave from ſcorching.

Bow, the bending, or round Part of the Ship forward; as *Buttock* is the ſaid Part at the After-end of the Ship.

Gunnel, the upper Part of the Ship's ſide.

Sheering-line, the upper faſhioning Line, and lays a little below the Gunnel.

Buttock, the After-moſt round Part of the Ship.

Timbering, to place the Ribs of the Ship in their Places.

Lower deck, and *Main-deck*, to be underſtood the ſame.

Riders, large Pieces of Timber plac'd upon the Plank within board, to ſtrengthen.

Knight-head-timbers, two large Timbers ſtanding on each ſide the Bow-ſprit, commonly with carv'd Faces.

Sleepers, thick Planks laying in the bottom of the Ship within board.

Spiling a Plank, to mark him out in order to work him.

MVSEVM
BRITAN
NICVM

FINIS.